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THE DEVELOPMENT OF SHAPE

Kurt Rowland

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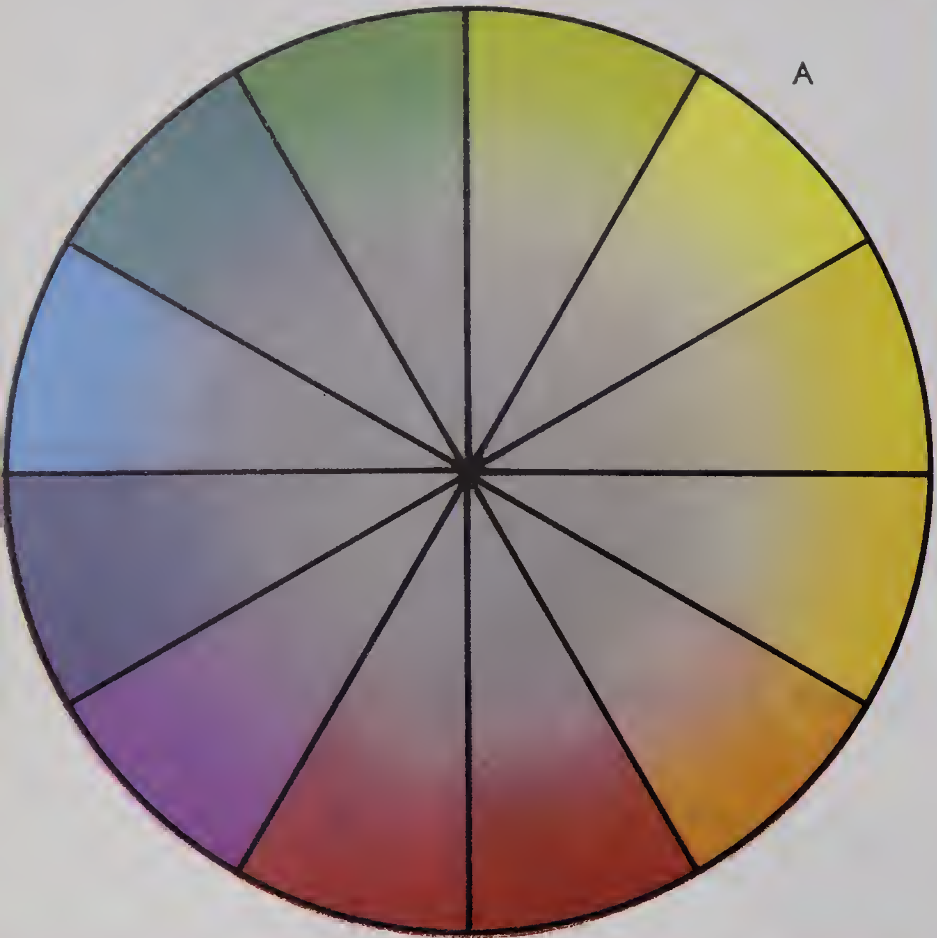
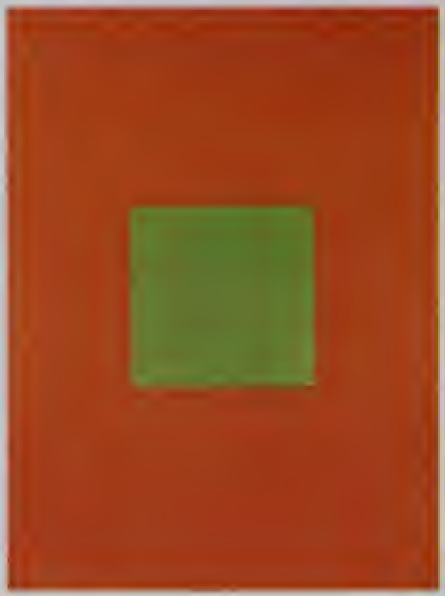
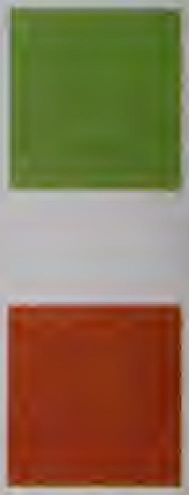
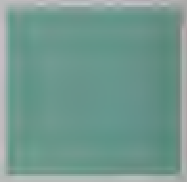
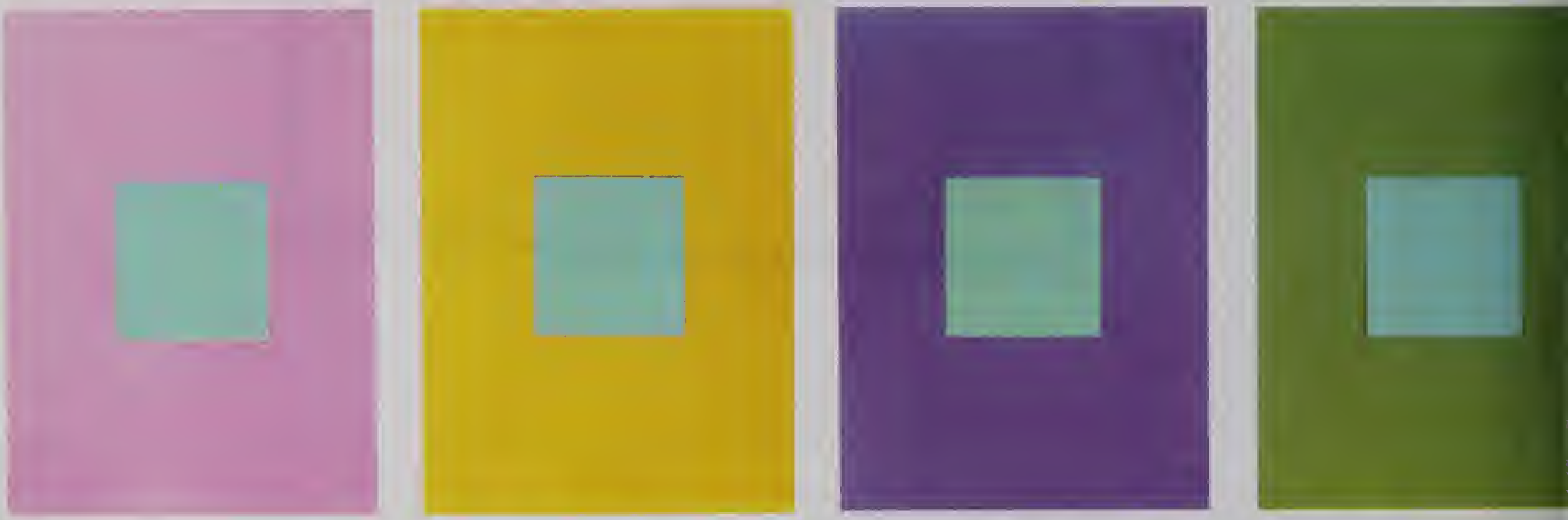




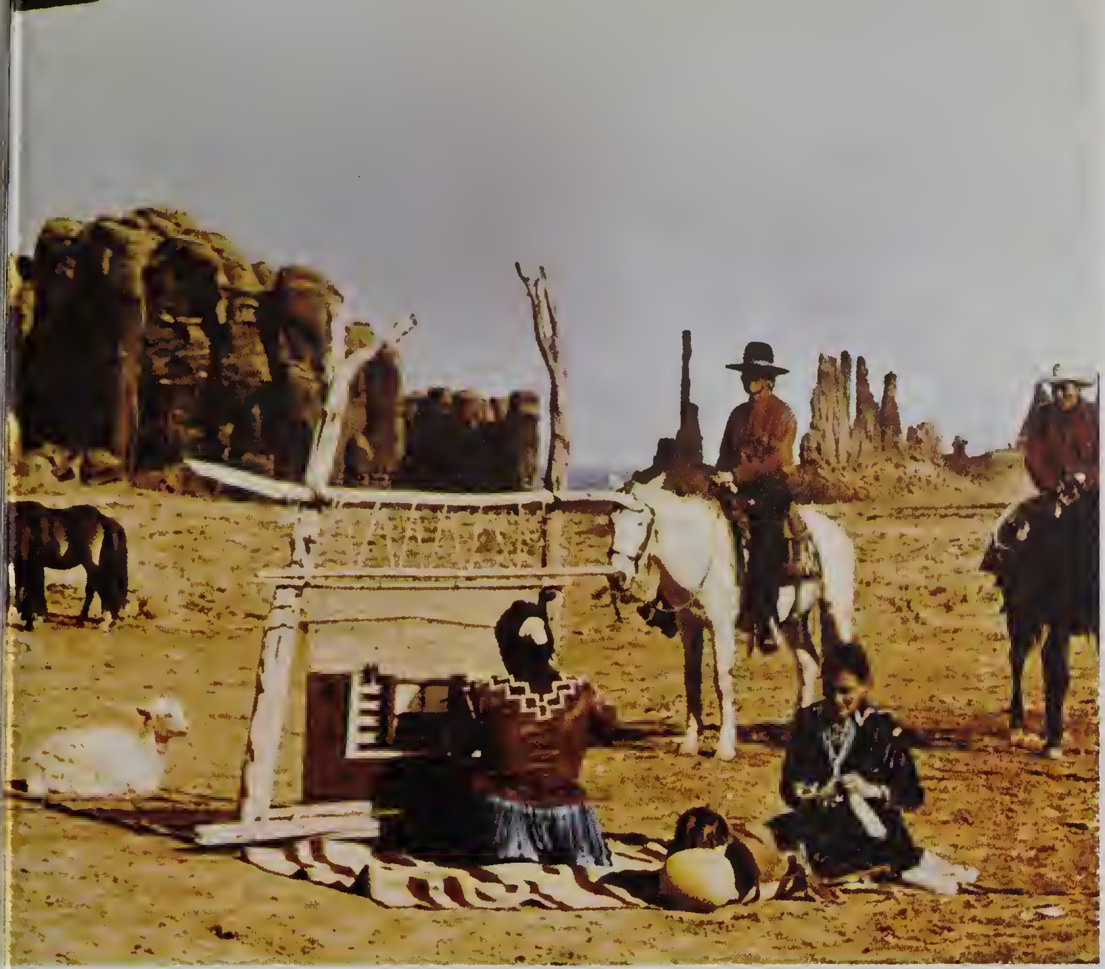


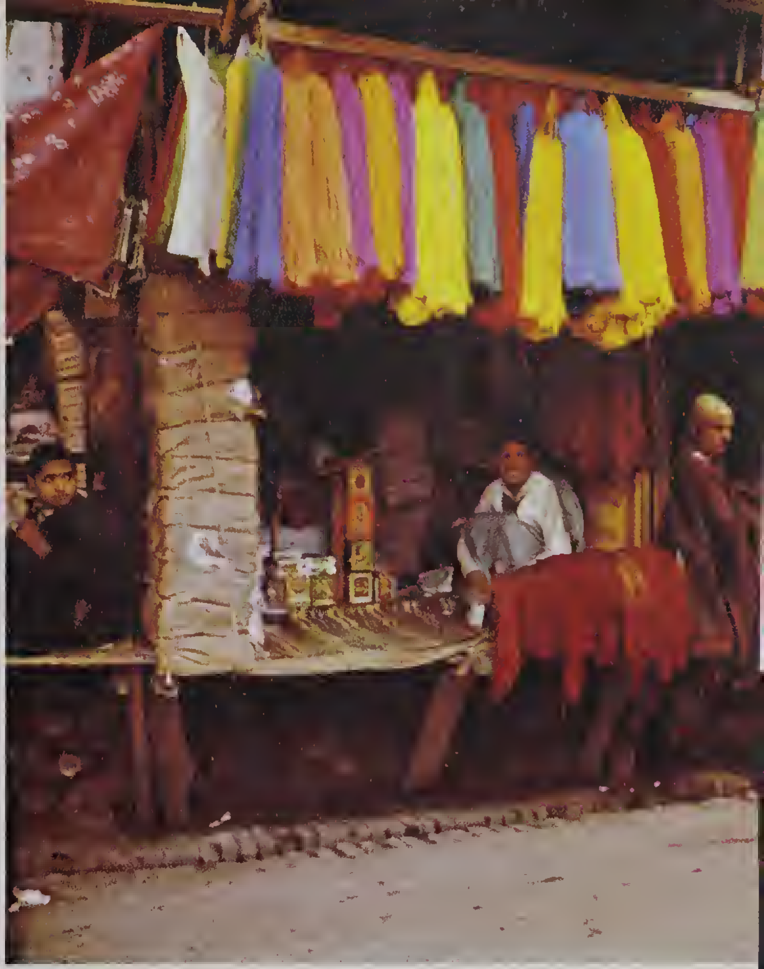


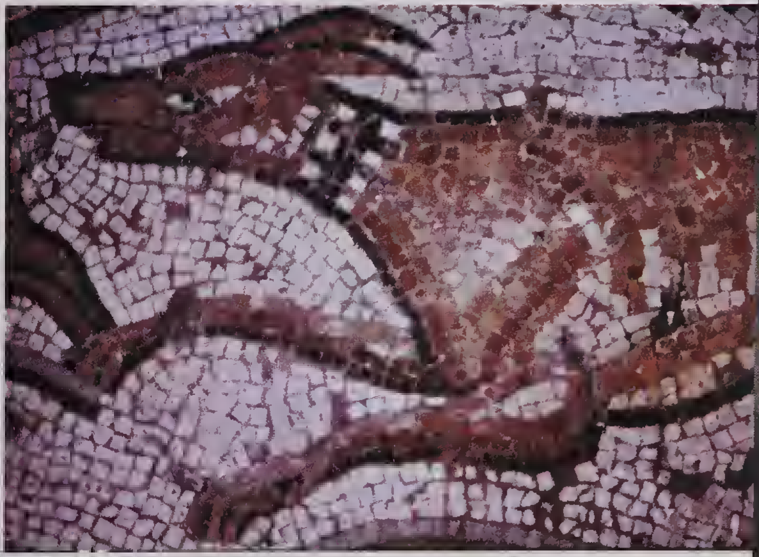


This picture shows the harmony of natural colours in an old town.

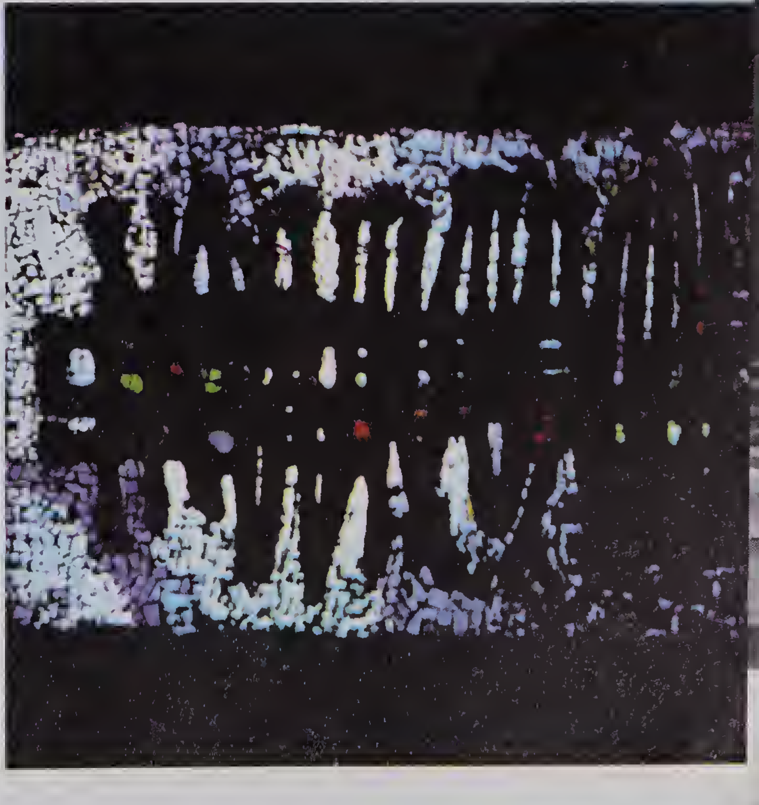
See pages 100 to 103 for an explanation of the colour chart.







In nature colours occurring together normally harmonise (above). Look at the colours of the design being woven (top left). Can you guess where the colours were obtained? When materials from the same neighbourhood are used, as in the mosaic, they will also blend together. The wools in the Indian market (top right) are dyed with imported colours and do not harmonise with the surroundings.



The modern stained glass window (bottom right) is entitled Winter. Do you think the artist has achieved a wintry effect? In what way does the colour contribute to this effect? The concrete into which the pieces of glass are set acts in the same way as the lead strips of older stained glass windows: it provides the neutral background which makes it possible to place such brilliant colours close together.

The shapes of the vacuum flasks are largely derived from the method of their manufacture. The division into different colours is also closely related to their manufacture. Colour and shape therefore work harmoniously together.

Looking and Seeing 2

THE DEVELOPMENT OF SHAPE

by Kurt Rowland MSIA

Ginn and Company Ltd.
London and Aylesbury

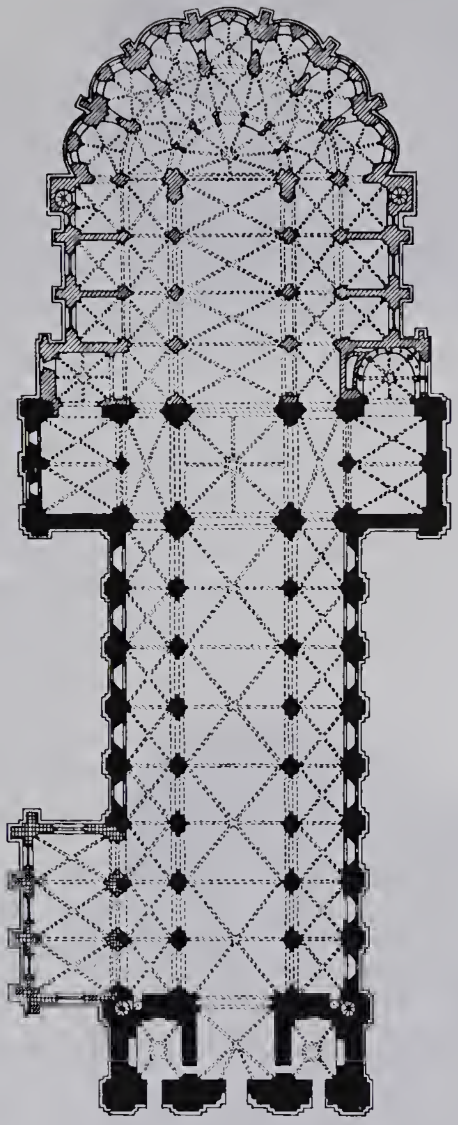
About this book

Part One of Looking and Seeing established certain basic principles which are essential to any visual understanding of the world around us. It showed that no single element in our surroundings can be considered in isolation, and that such related subjects as materials, production methods, function, environment, and social conditions have a far-reaching influence on our ability to make visual assessments. It is the purpose of Part Two to examine these ideas a little more closely. Together Parts One and Two provide a kind of visual grammar which will serve as a basis for the more complicated ideas discussed in Parts Three and Four.

There are many reasons for our present-day lack of visual comprehension. In recent years we have made great advances in science, and have gained considerable insight into the workings of nature, but we are still far from applying the findings of science to all aspects of everyday life. Our way of thinking, and as a result our way of seeing, is muddled. The visual confusion in our surroundings bears witness to this mental confusion.

The ordinary person, living in the mid-twentieth century, feels himself remote from many aspects of contemporary technology. He cannot keep pace with the development of new materials, involving as they do new processes of manufacture, nor can he grasp the complex and subtle needs of our scientific age. In earlier times, when life was less complicated, many ordinary people had a broad enough understanding of industrial methods and social needs to be able to judge for themselves the appearance and efficiency of man-made objects. Although today such all-embracing knowledge is impossible for any one person we must, as responsible members of society, learn as much as we can about the fundamentals of technology and design. Without such knowledge we cannot be sure of telling good from bad, and even less of recognising the best when we see it.

This book concerns itself with the relationship between shape, material, process and function. It attempts to show the general laws which govern the production of man-made objects, and how the visual language of a particular period or country is inseparably tied to its technological prowess and to its mental climate.



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I

1

The forces which shape materials

Picture **1** shows seven stones found in different parts of the country. If you saw them lying about you would not pay much attention to them. You would probably think that they were just ordinary pebbles like those you might find on any beach. If you inspected them more closely, however, you would see that they are not quite as ordinary as they seem. The stones fall into three quite distinctive groups of shapes. Three of them have fairly round, smoothed-off shapes; others have flatter surfaces which meet in points and edges; while two look simply blunted in an irregular way with neither the smooth roundness nor flat surfaces of the other two groups. Some of the surfaces of the stones in this third group are uneven and scratched. Let us find out what caused these shapes.
Many millions of years ago all these stones were part of huge masses of rock. These rocks were subjected to various natural forces and underwent a series of changes. The stones arrived at their different forms because the forces were not the same in each case.
The action of sun, rain, snow and frost often causes pieces to be broken off the rock substance of large mountains. When these pieces find their way to river beds, **2**, they are washed downstream. As they are jostled about by the strong current of the river they first of all lose their sharp edges, and as their long journey continues parts of the rock itself are worn away and the form of the stones begins to change. In the end they become the round pebbles you see in the picture.

In deserts pieces of rock, broken off the mountainside by the sun's heat, may come under the effect of strong winds which raise sand and blow it against their surfaces. If this goes on for a long time, the blowing sand wears away the pieces of rock and changes the form of the stones, but it does not produce round pebbles as a river does. These sand-blown stones form the second group of pebbles.

Stones brought down the mountainside by glaciers, **3**, are different again. They are less smooth than the stones in the other two groups; their edges are blunted and their surfaces scratched where they have come into contact with the bed of the glacier.

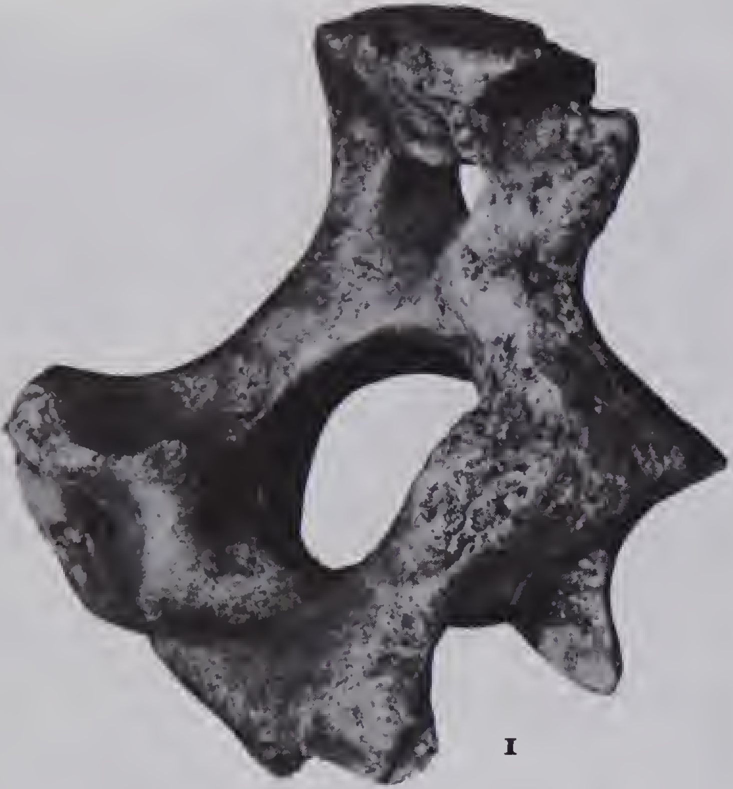
2

3

The wearing away of rock by natural forces is called erosion and the pebbles on page 4 belong to three different groups because they were formed by three different kinds of erosion. There is a relationship between the forces which make a shape and the shape itself. Different forces produce different shapes, as these pebbles show. But this is not the whole story; the form of any object depends also on one other thing: the material it is made of.

Picture **1** shows a stone which has been eroded in an unusual way. It is not at all like any of the pebbles we have been discussing, although the forces which shaped it were very similar to those which shaped them. These forces worked over the whole surface of the stone in the same way. This stone, **1**, is made of different kinds of rock mixed together, some softer and some harder. The soft parts could not resist the forces of erosion and so were worn away more quickly than the harder parts. The odd shape of the stone was caused not only by the forces which acted on it but also by the materials of which it is made.

This happens also on a larger scale. Sometimes the different resistance of different kinds of rock gives rise to the most fantastic shapes, as in pictures **2** and **3**. We can see that in nature there is a definite relationship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between material, the force which shapes it, and the form which results from this shaping. If either the material or the force changes, the form which results must also be different.

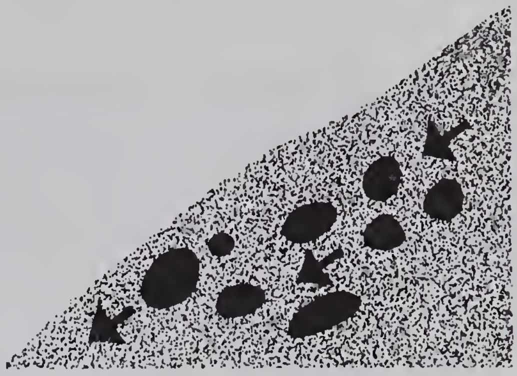
There are other natural forces capable of shaping stones. In diagram **4** you can see how one of these processes works. It is a downward movement of soil caused by the action of glaciers. Diagram **5** shows how flints may be chipped and broken by soil creep and the kind of forms which may result.

Flints may also have been chipped accidentally in other ways, by the hooves of running animals, for instance, or by a fall down a steep hillside, and shapes like **6** may have come about.

Imagine yourself stranded on a desert island without any of the useful objects so necessary to our daily lives. Would you not think that a stone shaped like the centre one in picture **5** might be very useful? What could you do with it?

Amongst the earliest tools used by man, flints broken accidentally played a very important part. These shapes would be likely to suggest a number of uses to people without tools. With such tools it must have been much easier to skin animals, to grub up roots for eating, and to cut wood. Some Australian aborigines have not advanced much beyond the stage of those early tool users. Picture **7** shows how they use stone tools today, and it is thought that early man used them in a similar way. They must have been very useful to him, for as he could not find nearly enough naturally shaped stones to satisfy his needs he learned to make some for himself, by imitating the shapes which nature had suggested. How would you set about it if you were faced with the same problem?

At first the early toolmaker could do little more than imitate the forces of nature which had given him his first tools. Drawing **8** shows how he probably did it. Compare this with drawings **4** and **5**. He had never



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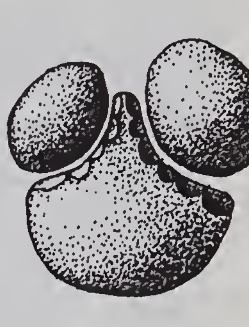

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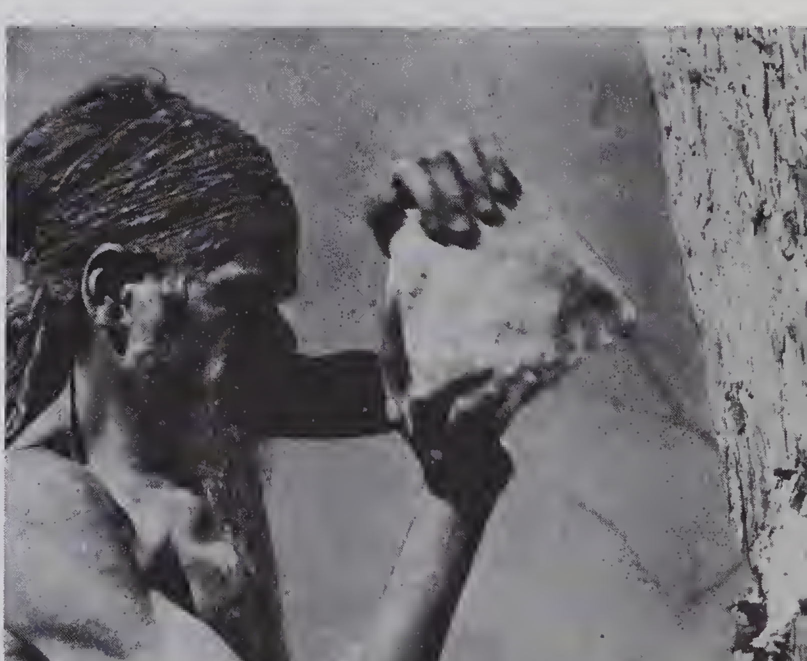

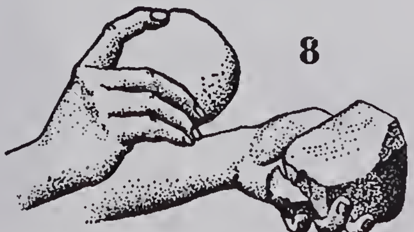

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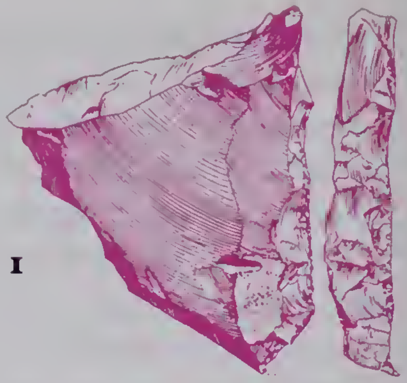
8. *How early stone tools were probably made*

made a tool or seen one made by another human being; he knew only those which he had found already made. In order to reproduce natural shapes he had to use a similar method to nature's, and the same materials. The earliest man-made tools are rather like natural flint forms. In fact it is difficult to be quite certain which are natural and which are man-made. If you found flints like **1** and **2**, could you decide which was the man-made tool? They look very much alike, but **1** is thought to be a flint which was chipped by natural causes, while **2** was worked by a human being.

In this way early man discovered the relationship between the force (we might call this the method), the material, and the resultant form. Having learnt this fundamental lesson, he set out to improve his method and his materials. He searched everywhere for the best flints, digging in the earth to obtain those which would flake and wear better than the ones he found on the earth's surface. Gradually, over the course of thousands of years, better methods and better materials produced greatly improved tool forms. There is a vast difference between the stone tool, **5**, and the earlier one, **2**, which was no more than an exact copy of what man had found in nature. Through thousands of years man gradually discovered more about the true character of his material, and then developed a suitable method of shaping it. The result is a range of shapes much more efficient than the earlier ones, and as pleasant to look at as they are efficient. For their purpose, these shapes could not be bettered.

Although stone was a very useful material, it was not suitable for all the shapes required for tools and weapons. Man found that for certain purposes other materials were more efficient. Pictures **9**, **10** and **11** show tools and utensils which were not made of stone because stone was not the right material for such shapes.



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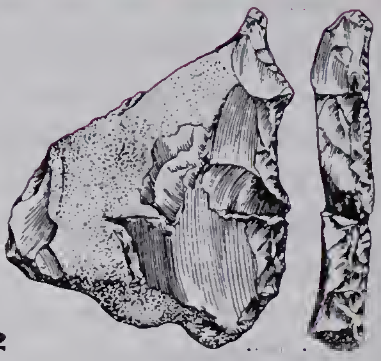

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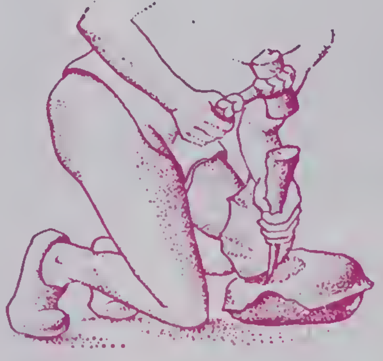
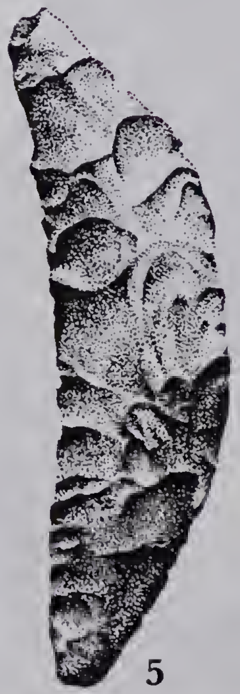


4. *Indirect flaking allows the tool-maker to control the shapes of his tools with more certainty. Arrow heads,* **3**, *sickles,* **5**, *and daggers,* **6**, *could not have been produced by the method you saw in* **8** *on page 7.*

4



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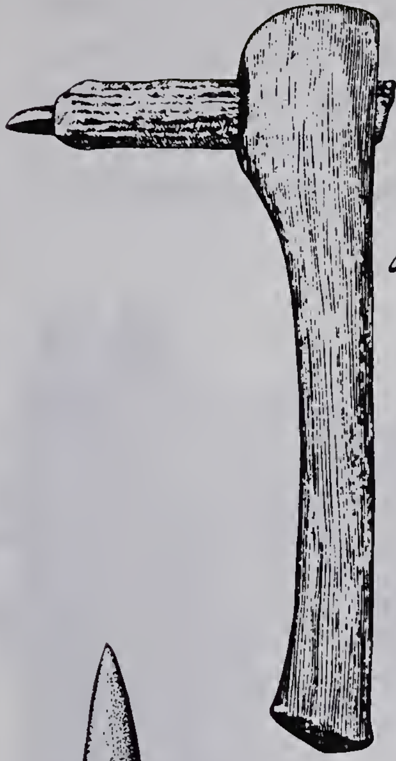
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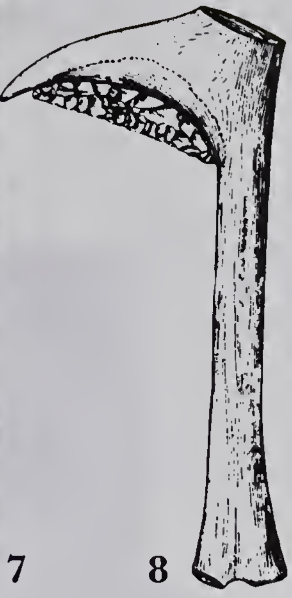
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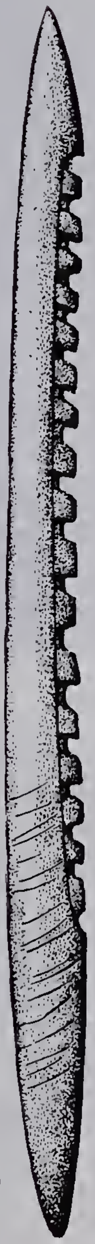
Gradually the early tool-maker discovered that different materials could be combined, to make tools of even greater efficiency. Wood, bone, antler, and shell were combined with stone to produce a whole range of tools which any one of these materials alone could not have provided. The sickle, **8**, for instance, is a better tool because it combines the sharpness of flint with the lightness and pleasant feel of wood.

Looking at these tools we can see how far man had come since he first started making tools. He had realised that each shape is the result of applying one particular method to one particular material, and he was learning to do this more and more efficiently. Man has been described as a tool-making animal, and it is his ability to make tools which has distinguished him from all other animals.

That is why this first stage of man's tool-making career is so important. If early man had not developed his great feeling for the right use of various natural materials, his tools would have been very much less efficient and perhaps he could not have succeeded, as he has, in dominating the rest of nature.

At a time when man had reached a peak of efficiency in making stone tools, he discovered, probably quite by accident, that certain stones contain metals. It was then found that some of these metals could be combined into a material, bronze, for shaping into tools. It is not surprising that the shapes of early bronze tools and weapons should resemble those of the stone tools already being produced. You must remember that tool shapes had been developed and perfected over many thousands of years, and it did not occur to the early craftsmen that there might be other shapes. When bronze was introduced, they tried to copy in the new material the shapes they had always made in stone. As they gained more experience of bronze, however, they began to find new and more efficient shapes for their tools. These new shapes were closely related to the character of the new material.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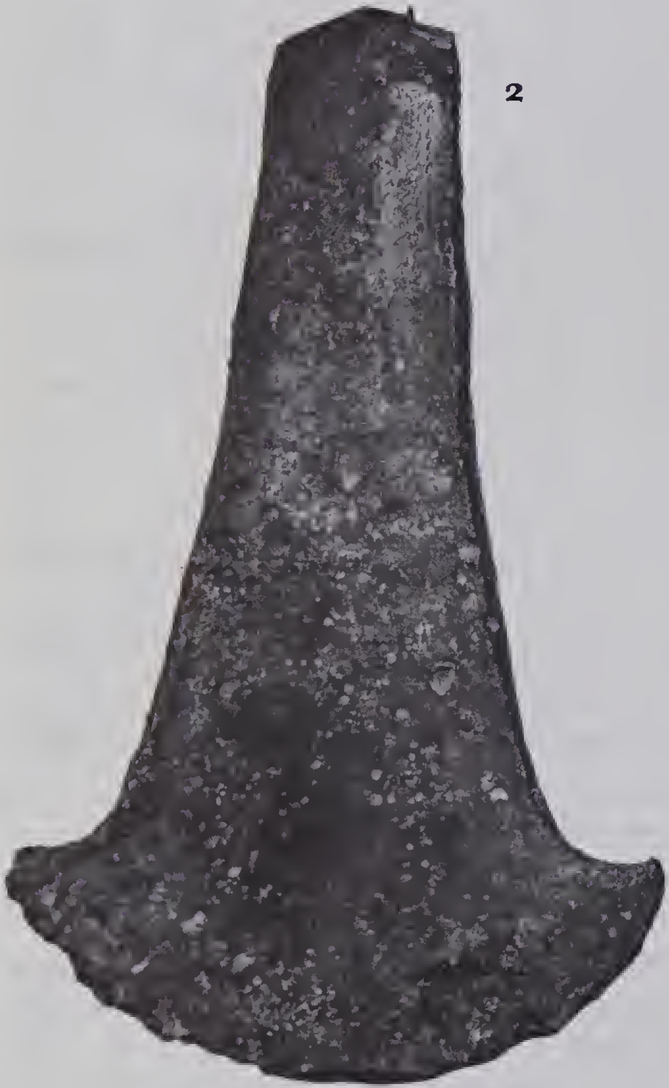
10

11

7. *Adze made of wood, antler and flint* **8.** *Sickle made of wood and flint* **9.** *Bone harpoon*
10. *Weaving comb made of antler*
11. *Bone pin*

1

This kind of implement, **1**, is called a *celt* and is the forerunner of our axe. The earliest bronze celts were made in the shape of the stone celt.
A stone celt was formed by removing portions of stone, by chipping and grinding, until the desired shape was obtained. A bronze celt, however, was cast in a stone mould, **6**, and then hammered into the required shape. The cutting edge was produced by beating until it was thin and sharp. One of the great advantages of bronze over stone was that if it became blunt it could always be beaten out again, and the tool restored to its former efficiency. Now, if you have ever tried to make anything out of plasticine, you will know that the beating process is likely to give a broad, curved edge, like that in picture **2** of a bronze celt. Picture **3** shows the next stage in the development of the bronze celt. The small flanges along the sides were produced by hammering. You will notice a ridge across the middle of the tool. This ridge does an important job: it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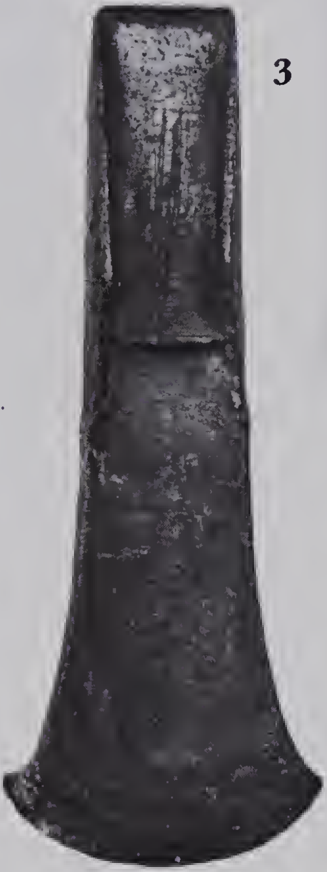
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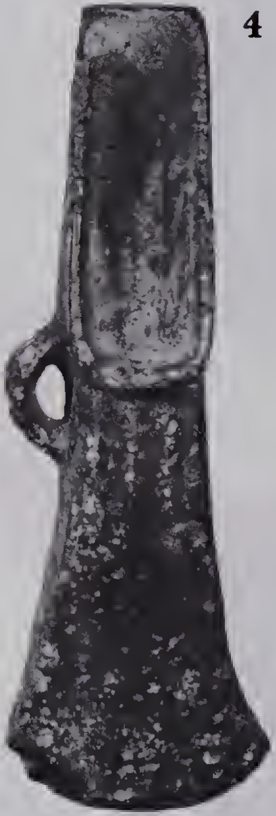
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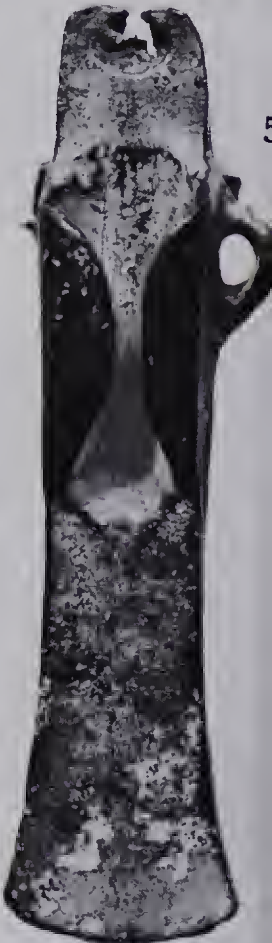
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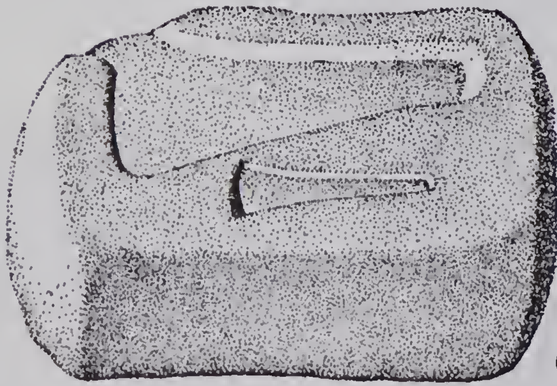
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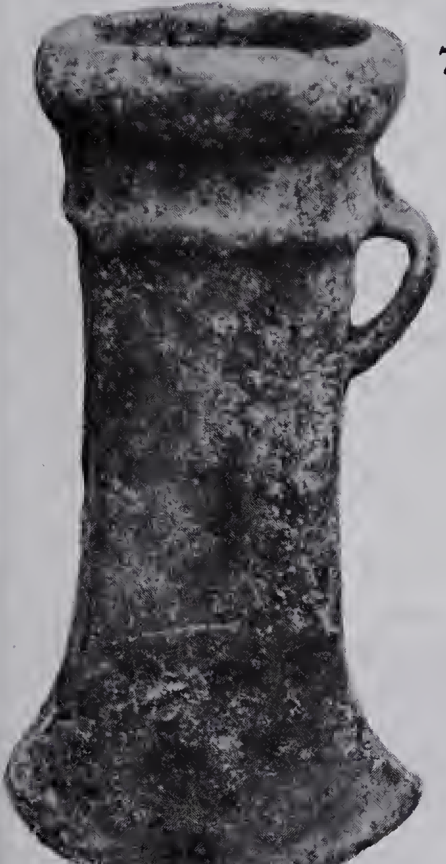
prevents the rear end of the celt from cutting into the wood of the handle, **10** and **11**. The addition of a loop and the combination of flanges and stop ridge into one shape, **4**, mark a further stage of development. You can see that the changed shape of this tool was the outcome of a new material which required a new method of working. This shape could not have been made in stone.

But development did not stop there. Picture **5** shows how the small flanges grew into wings and eventually led to the socketed celt, **7** and **12**. This tool is a far cry from the early stone celt, **1**. It makes efficient use of the new material and has a shape quite impossible in stone or any other material at that time known to man.



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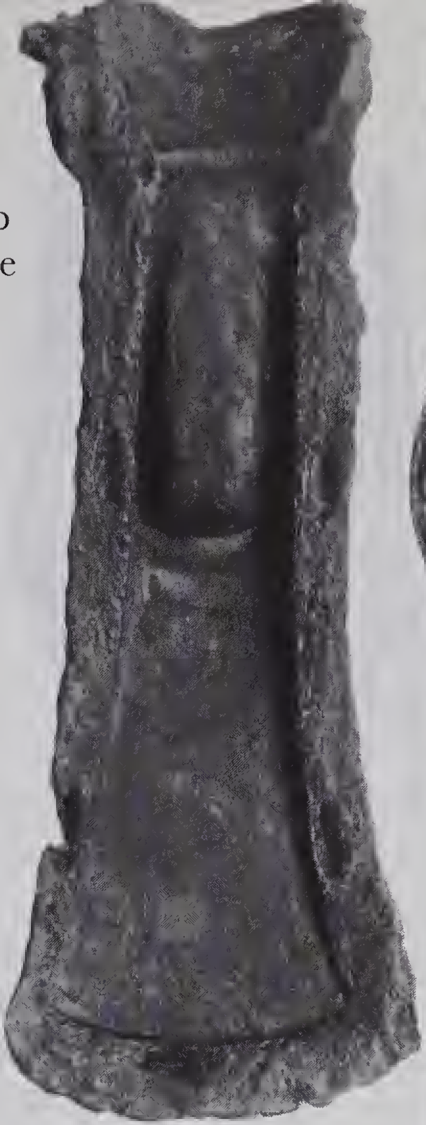
*Compare these moulds, **8**, made of stone, and **9**, made of bronze, with the early stone mould, **6**, and you will see that the maker of bronze tools had to learn the skill of mould-making before he could produce good tools.*



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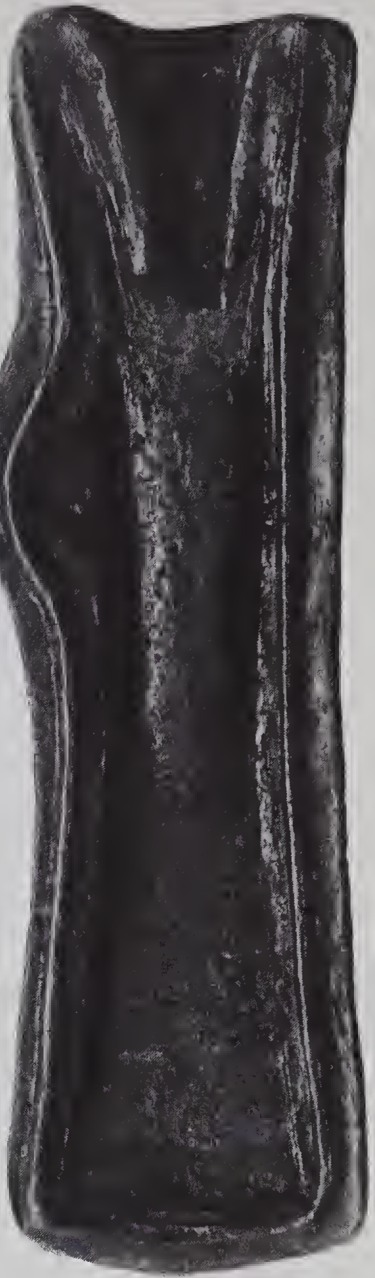

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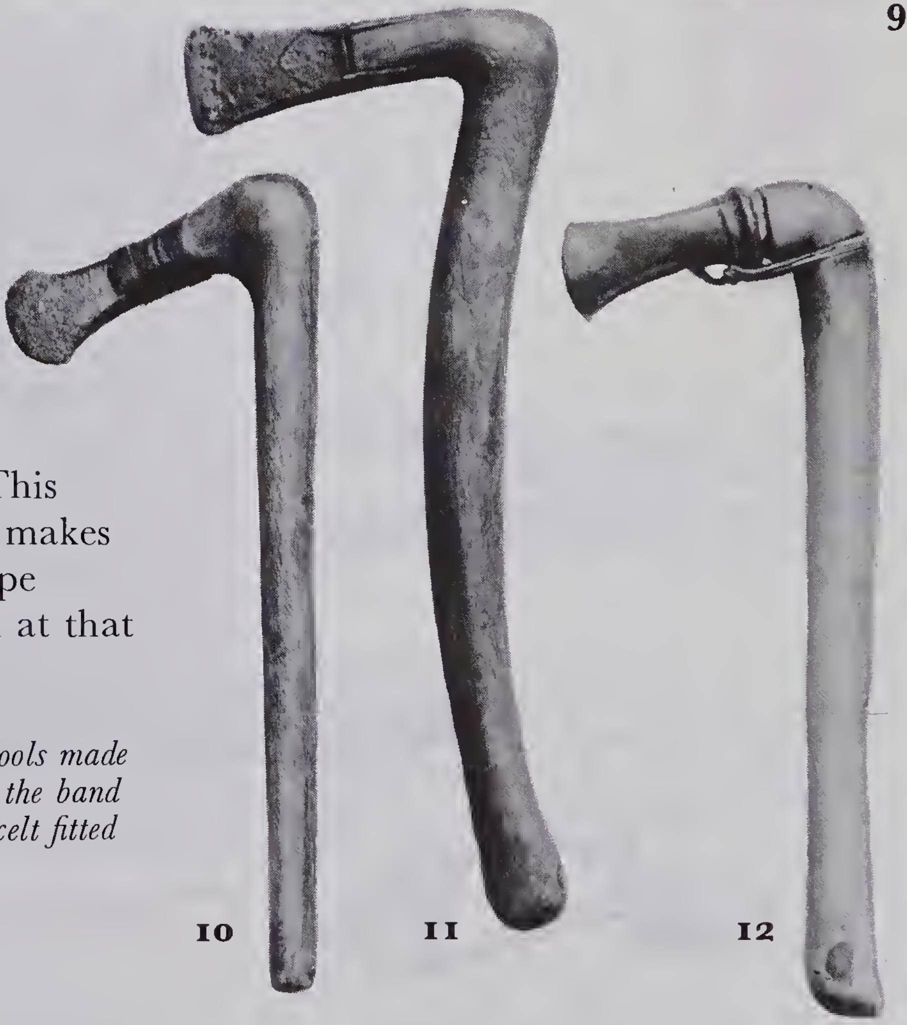
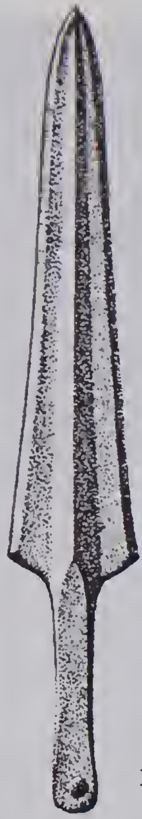


*Pictures **10**, **11**, **12** show how tools made in this way were hafted. **11** has the band removed to show how shaft and celt fitted together.*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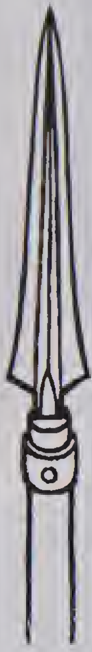
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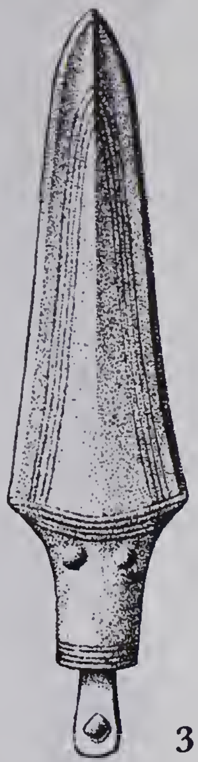
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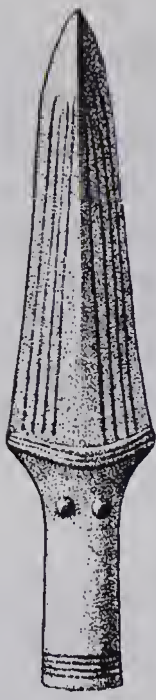
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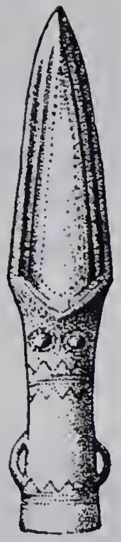
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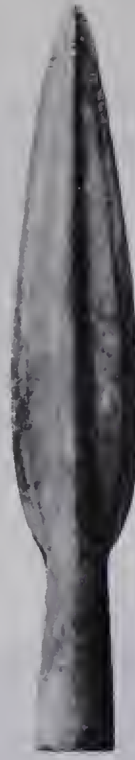
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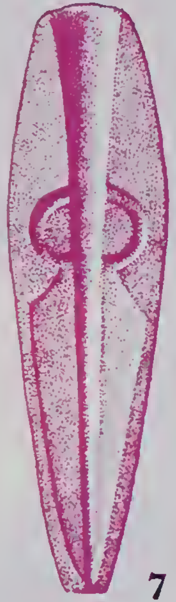
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1 *to* **6**. *Development of the bronze spear*
7. *A mould for a bronze spear*
8. *A bronze sword* **9**. *A bronze brooch*
10. *A pair of bronze tongs*

The bronze spear head, **1** to **6**, is another interesting example of the development of form. Once again it began as an imitation of a stone shape, **1**. The introduction of the rivet and collar, **2**, was the first great improvement. Then it was found that the collar could be riveted to the spear head itself, **3**, making it firmer, but still leaving the tang. With the invention of hollow casting, collar and spear head could be cast in one piece, **4**. The heads of the rivets were kept as an ornament, although they were now quite useless, and the tang was left out. Later, two loops were cast with the spear head, **5**, for tying it to the shaft. In turn this device, too, lost its use and was omitted. Finally the perfect shape for a bronze spear head was arrived at, **6**.
All tools and utensils underwent similar changes, brought about by the use of the new material, and by new methods needed in working it. Entirely new tools were invented, **8** to **10**, among them the sword and the brooch. It is obvious that these could not have been made in any other material in use at that time.

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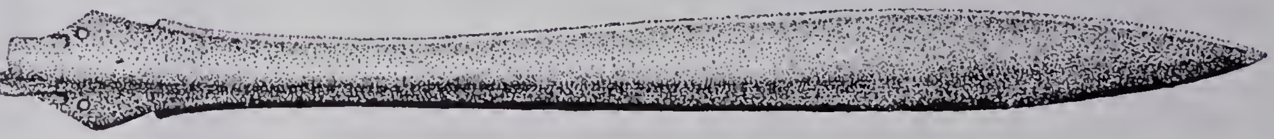

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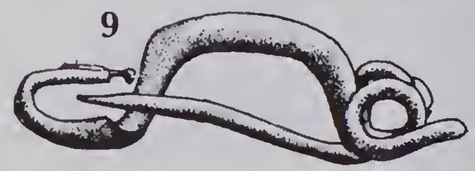

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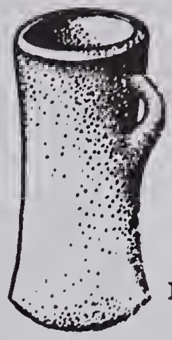
With the discovery of iron, the process of development was repeated. Picture **11** shows how bronze implements were at first imitated in iron, just as stone implements had been imitated in bronze. Soon the new material suggested new forms which proved to be more efficient. A large ploughshare, **12**, impossible before, could now be made, with great benefits to the community. The Iron Age toolmaker also invented entirely new tools, as his predecessor of the Bronze Age had done. Shears for example could now be made, because iron was sufficiently strong and springy for the purpose, **14**.

The people of the Iron Age extracted iron from its ore by smelting it and then hammering the mass so obtained to remove the unwanted materials. They could not achieve high enough temperatures to liquefy iron, which melts at a higher temperature than bronze, and so the knowledge of casting learnt during the centuries of the Bronze Age could not yet be applied to iron. When you look at tools produced during the Iron Age you must remember that every one was forged and their shapes are therefore peculiar to forging and not to casting.



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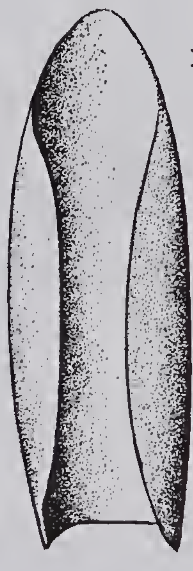

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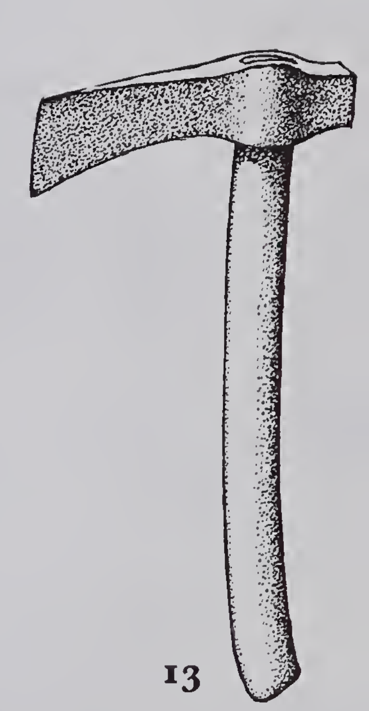

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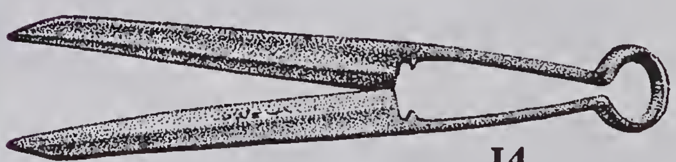

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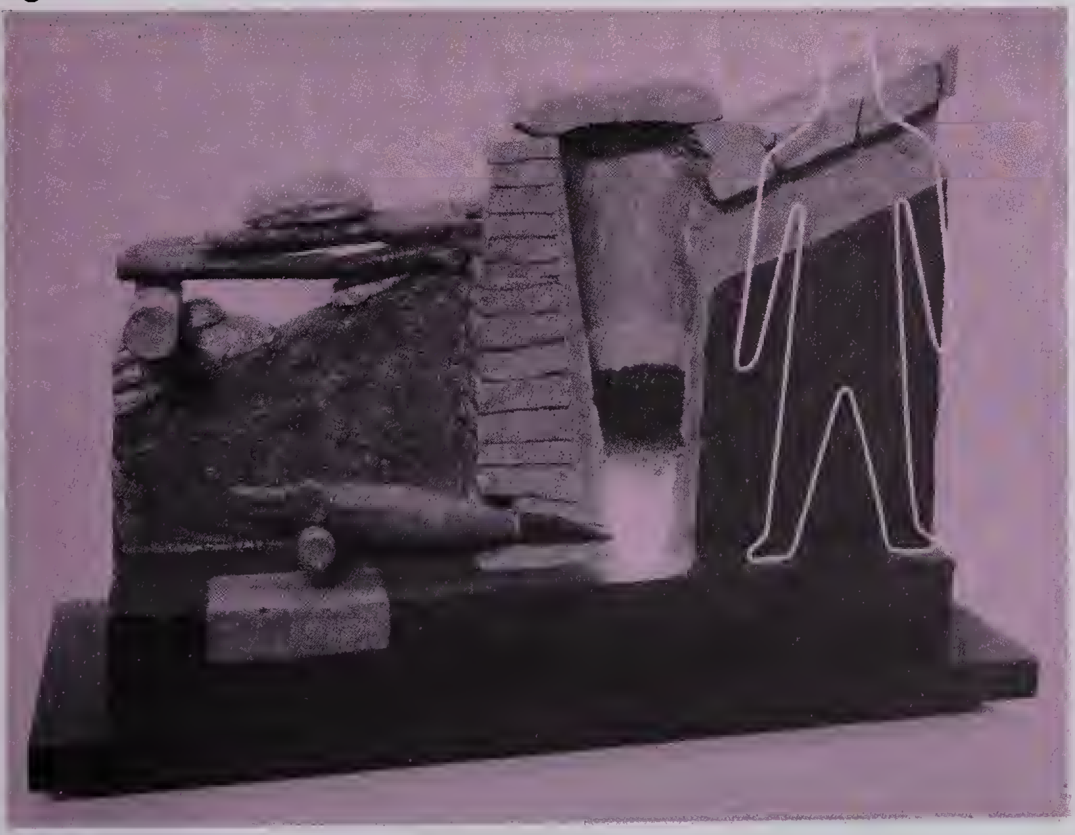
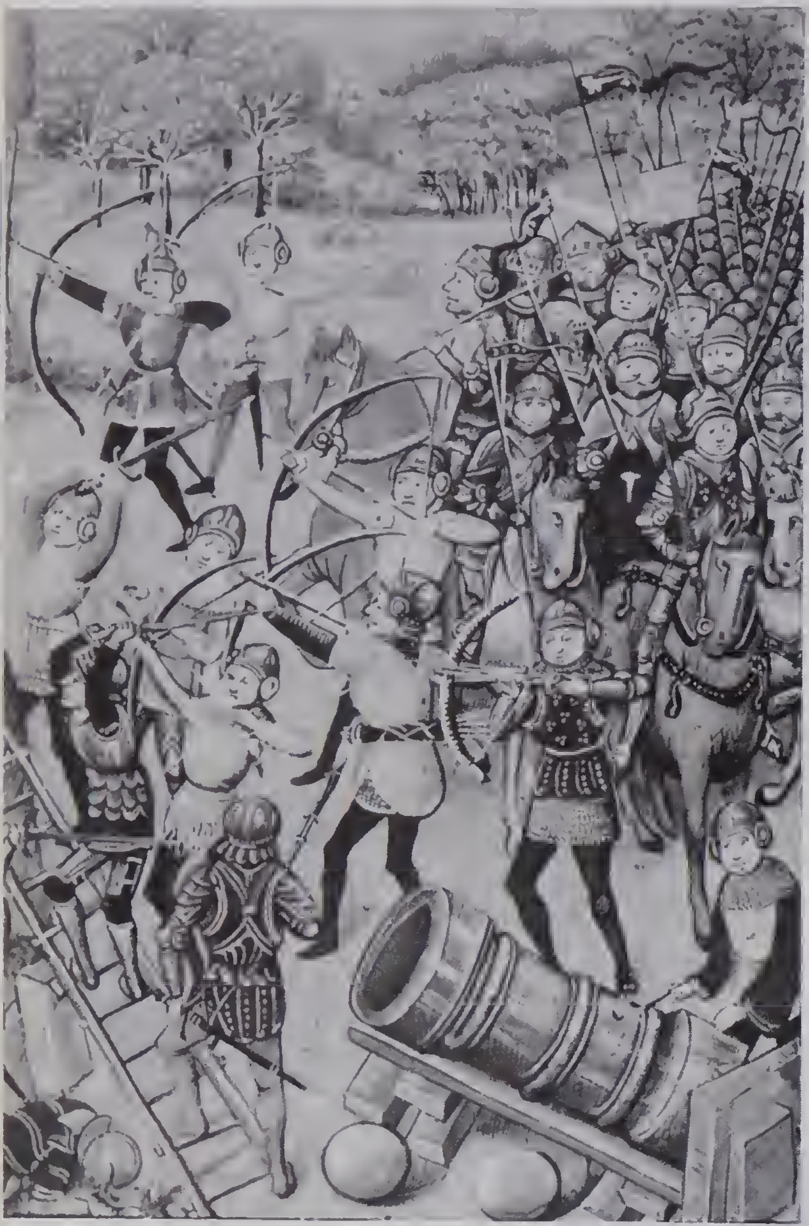
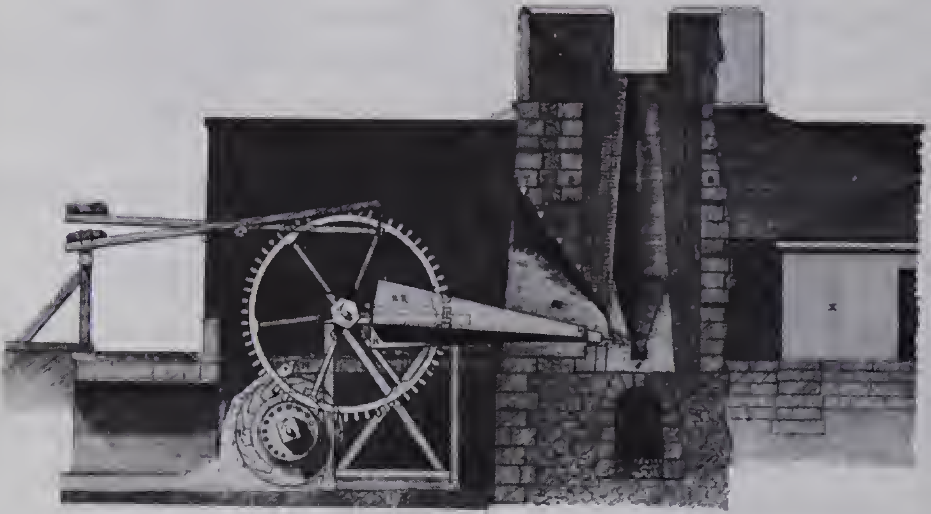


13. *A Roman iron axe*
14. *An early pair of iron shears*
15. *A model of a Roman smelting furnace with bellows. You can easily imagine its size by comparing it to the outline drawing of a man.*

I



When, at last, in comparatively recent times, technicians invented a way of achieving the high temperature necessary for casting iron, an entirely new range of shapes became possible.



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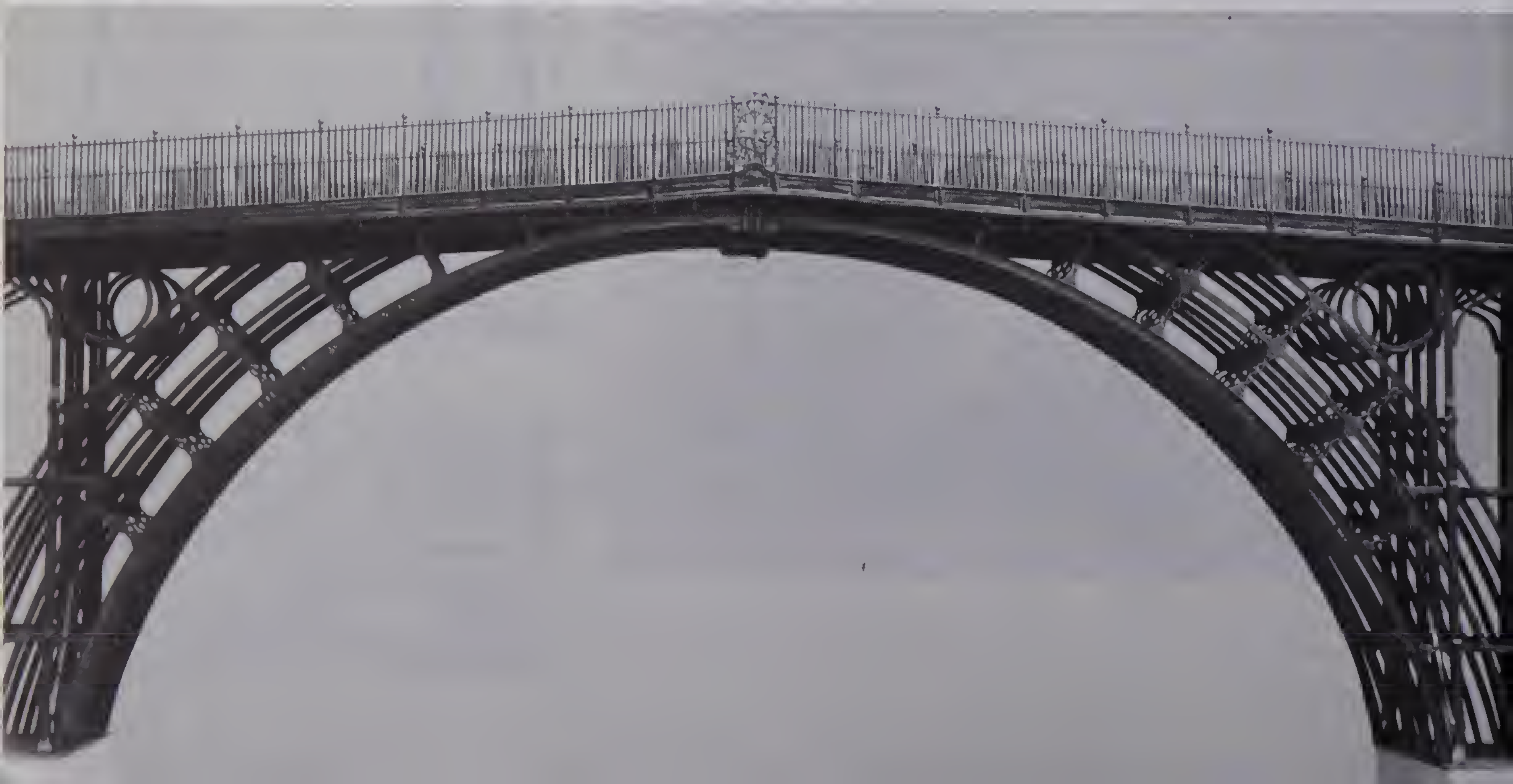
By the fourteenth century furnaces were sufficiently improved to make it possible to liquefy iron, although the process was still unreliable. This fifteenth century gun, **I**, *owes its shape to the fact that it could now be cast. By the eighteenth century, blast furnaces,* **2**, *gave consistently high temperatures which made possible elaborate cast iron constructions like this bridge,* **3**.

3

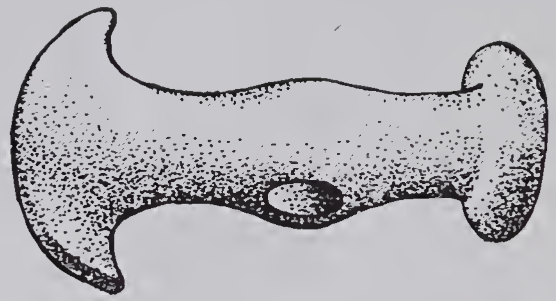


TO SUM UP

Form is the outcome of a force, or forces, acting on a material. This force may be the action of water or wind, or of human hands or tools. To understand a form we must always bear in mind the forces (or methods) which have shaped it. We have observed a number of changes in the shapes of man-made objects and found that these are always related to the materials and the methods of working. When the material is changed the shape changes with it; when the force which forms it (or the way of shaping it) changes, the shape also changes.

EXERCISES

1. Picture **4** shows a stone axe. It was made at a later date than the other stone tools you saw in this chapter. Can you see that it is made in imitation of a metal tool? Explain what makes it a good shape for metal but quite unsuitable for stone.
2. The two capitals, **6** and **7**, come from two different periods. Both are made of stone, but **6** was hewn with an axe as was customary during early Norman times. Later, during the period known as Gothic, masons learnt to use the chisel, as shown by **7**. Explain in what way the shape and pattern of the capital have changed as a result of the change of method.
3. Look at the wrought iron screen, **5**. Why do you think its various shapes are natural to the material and the process?
4. Can you think of any objects which have undergone changes in shape because of changes in the materials and methods used?



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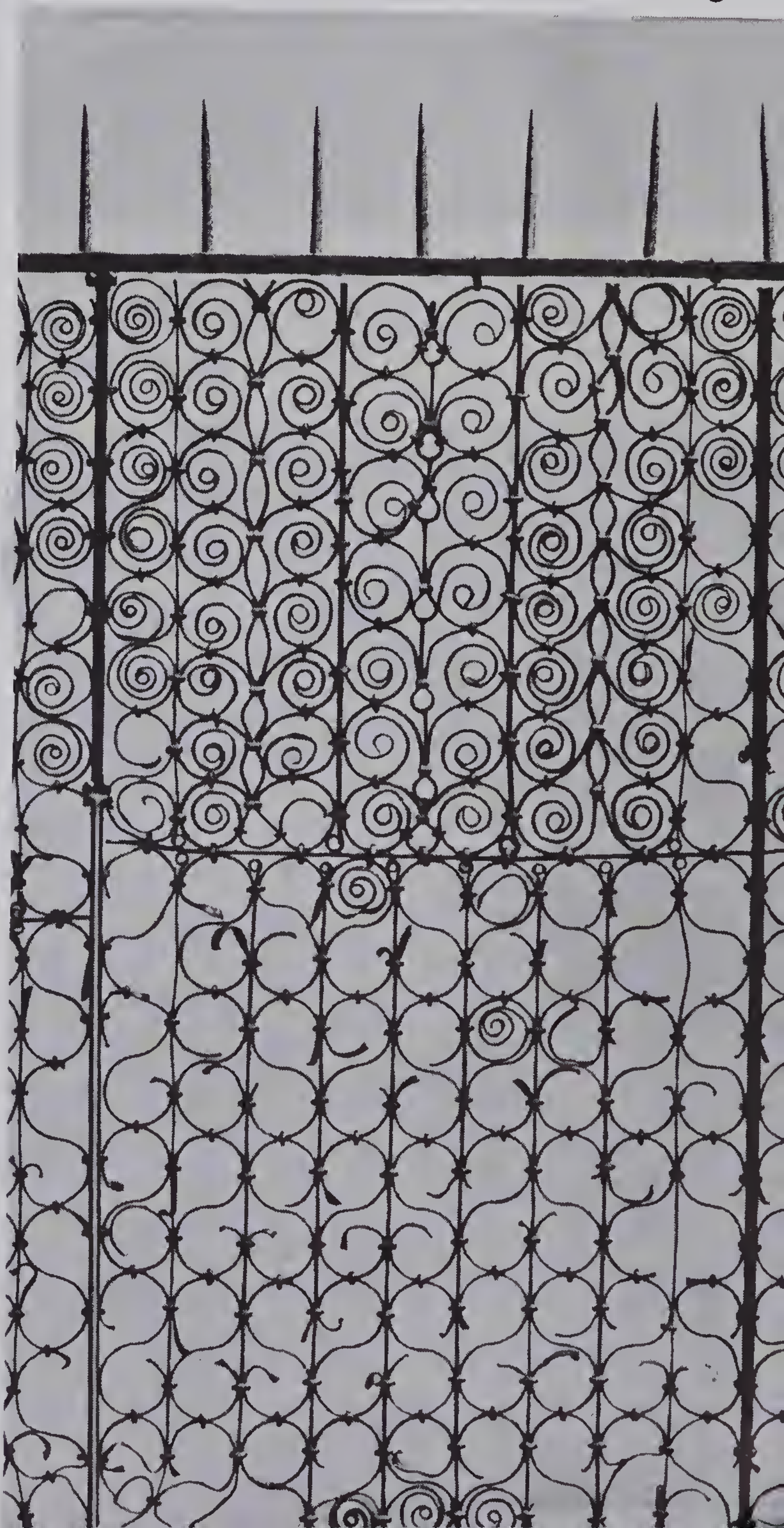

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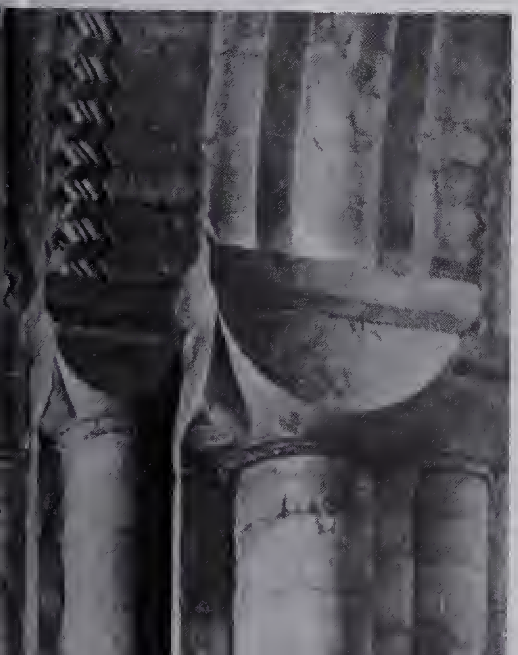

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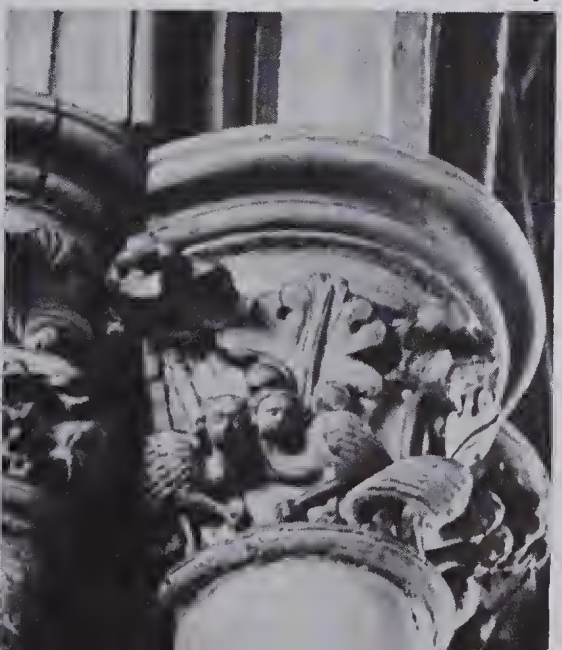
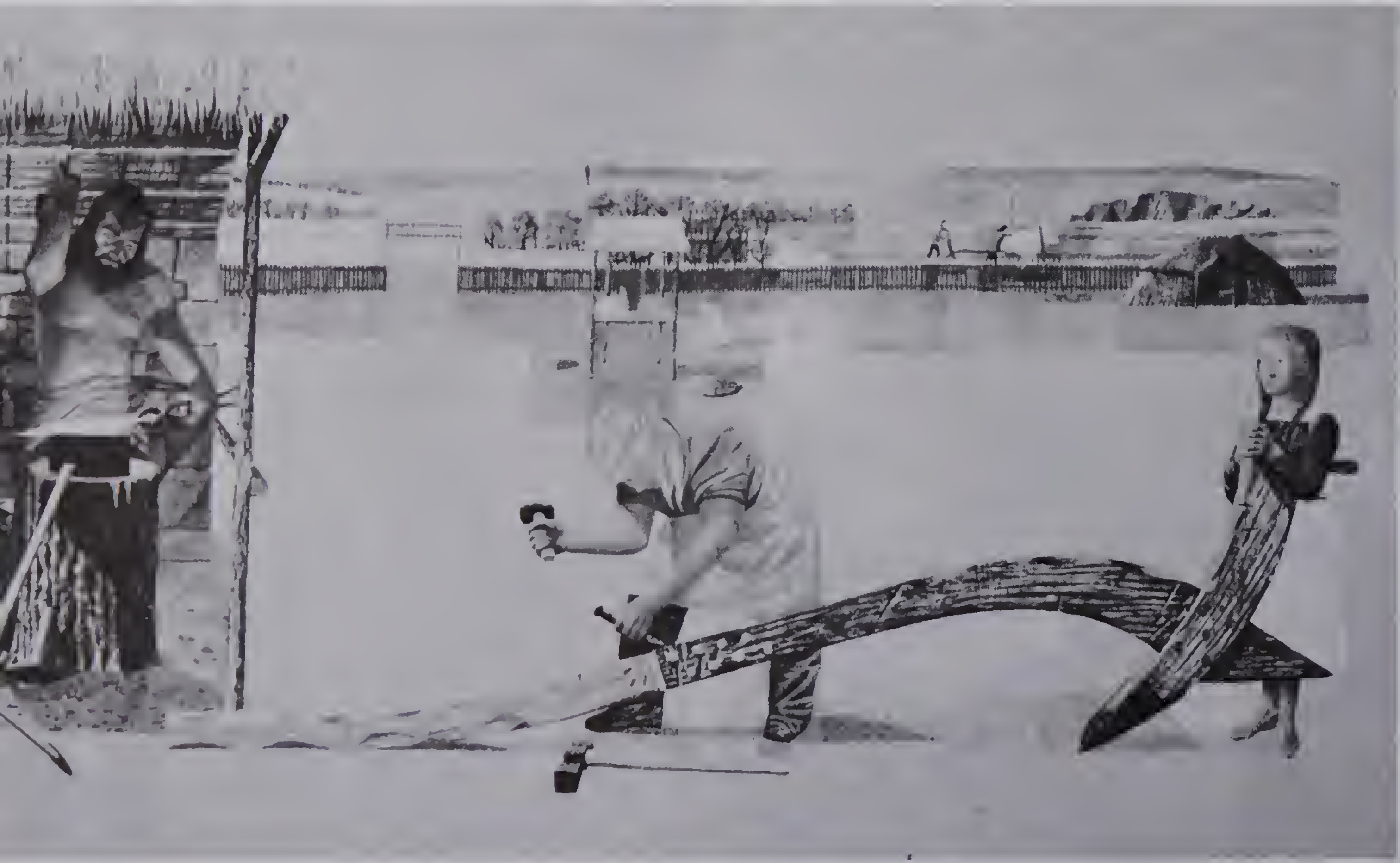


2

Modern materials need modern shapes

In the last chapter we saw that each combination of material and method created its own form or even a whole range of forms. These changes were not caused by any changes in taste; their makers did not introduce them to improve appearance or to make people want to buy them. Often changes took place against the intentions of the tool-makers and at times new developments must have surprised them. Beautiful shapes were created as a result of such changes, because the relationship between material and shape was right. For instance the late, fully developed bronze celt (page 11, **7** and **12**) is beautiful because the shape is suited to the material, while the first bronze celt (page 10, **2**) which was an imitation of the stone celt is ordinary and unexciting to look at. Perhaps you do not agree, but we can be fairly certain that the girl in picture **1** does. She is helping the two craftsmen and watching at the same time; no doubt she has watched before. She knows something about how tools are made. She knows the stages the tool passes through before it arrives at its final form, and she also knows why all this is necessary: she knows how these tools are used. Already she has an understanding of what a good shape is, one which uses



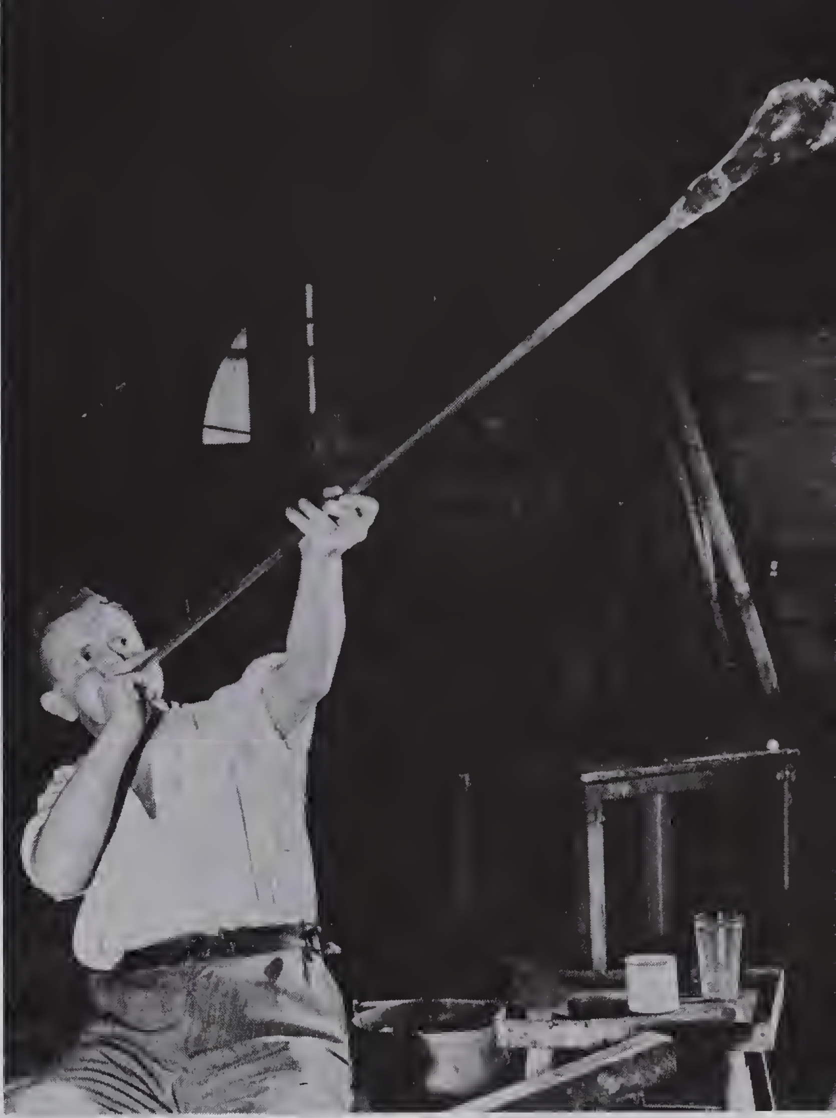
1

2

the material in the most efficient way, so that it can be put to the best possible use.

In a way she is like someone who cultivates a garden and watches for the results of his labour. The young shoots develop buds, which grow bigger and bigger until in the end they burst. The petals emerge, getting larger as they unfold, often changing colour and finally settling in a particular shape and pattern. If you have watched this process, day after day, the final shape of the flower will mean more to you than to someone who has only seen the last stage of its development. It is not enough to look at a finished shape; the development of any shape is an important part of the shape itself. If we are to understand a shape we must also understand something of the process by which it was made.

The production of a wine glass is in many ways similar to the unfolding of a flower. Pictures **2**, **3** and **4** help us to understand how the shape was made and without this understanding we cannot really judge whether it is a good or a bad shape. This craftsman, **3**, used all his great skill to produce a shape which could not have been produced by any other means, a shape which expresses the character of glass.



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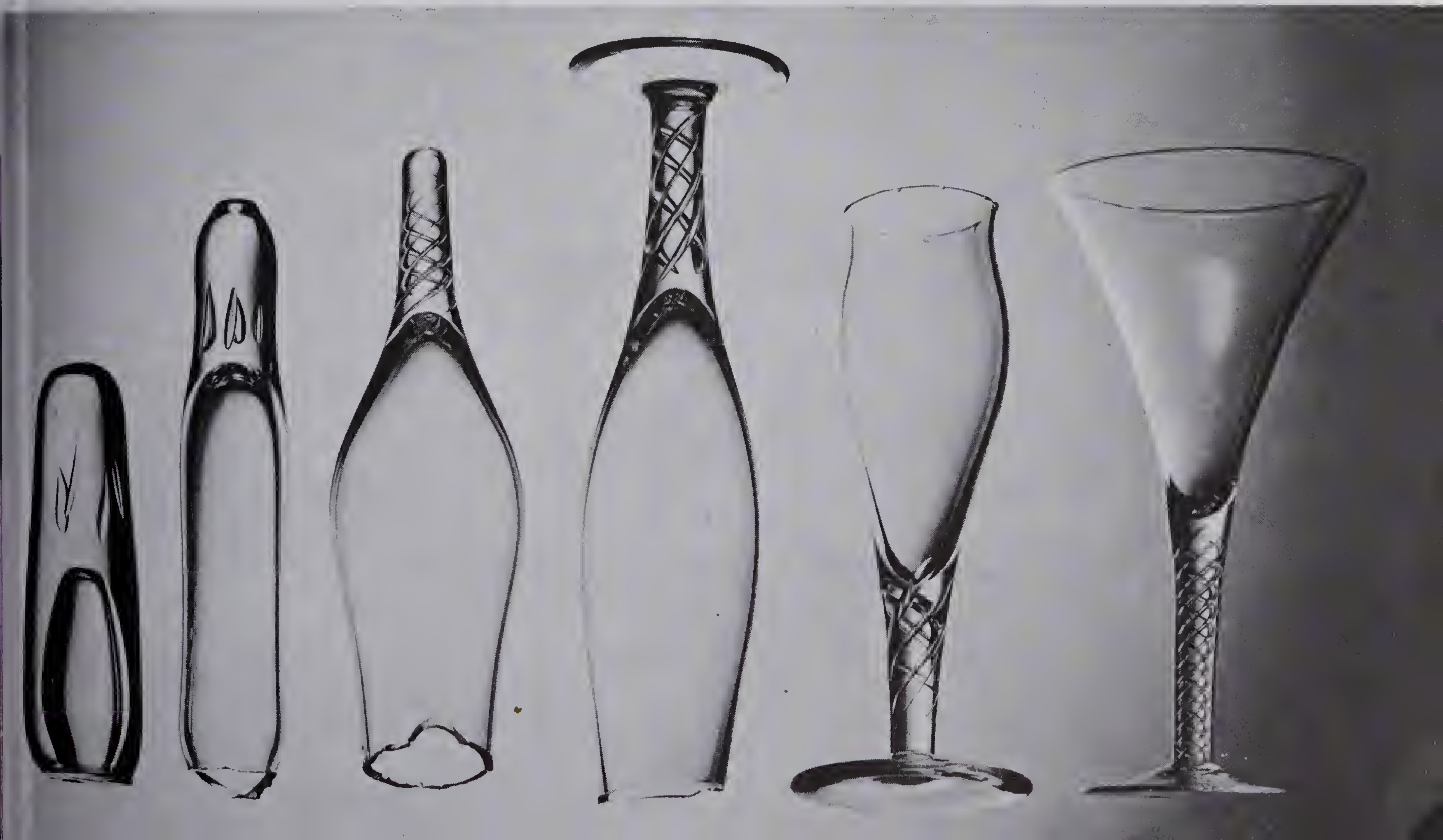
3. *How a wine glass is blown*
2, **4**. *Various stages in the production of a wine glass*

4

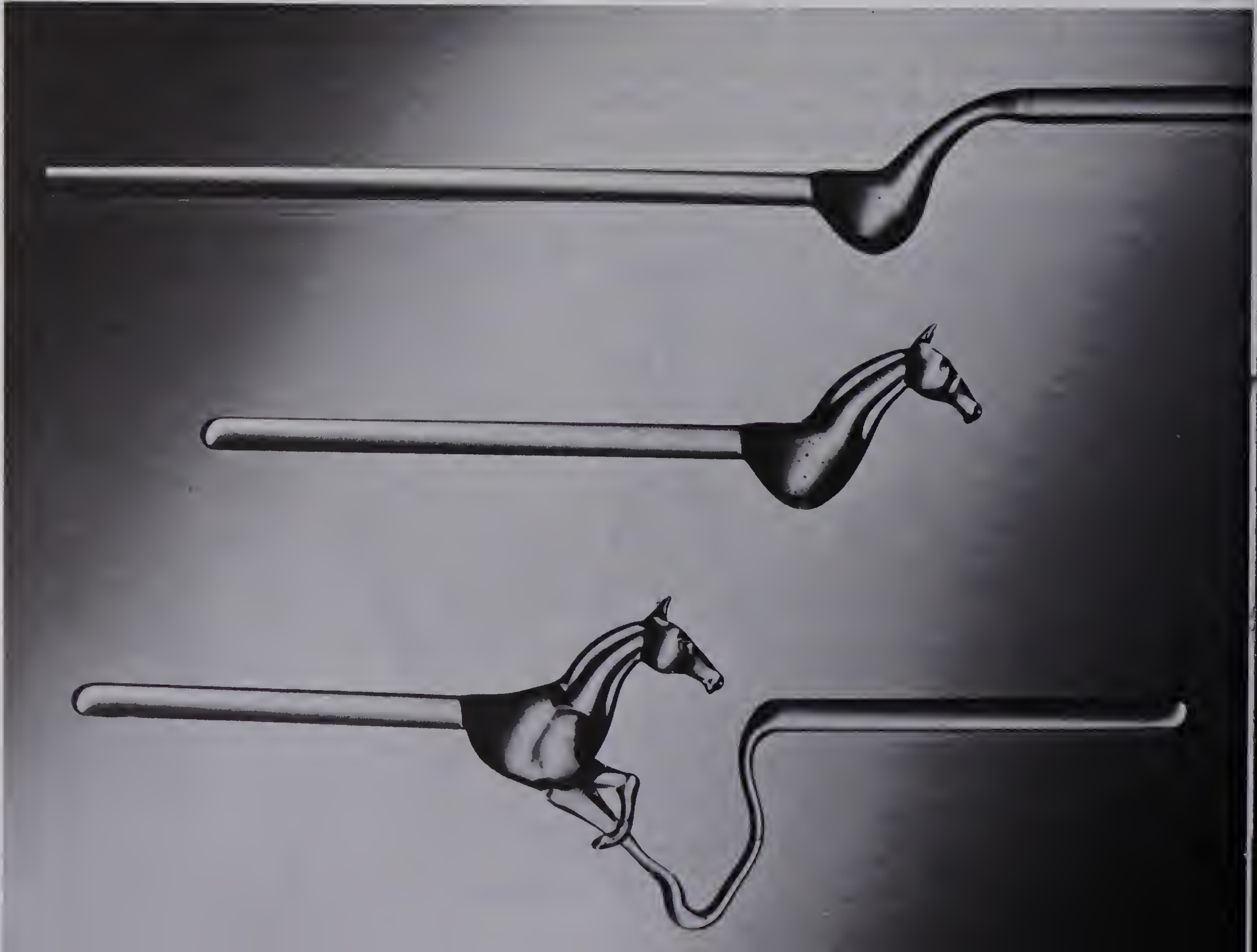


1

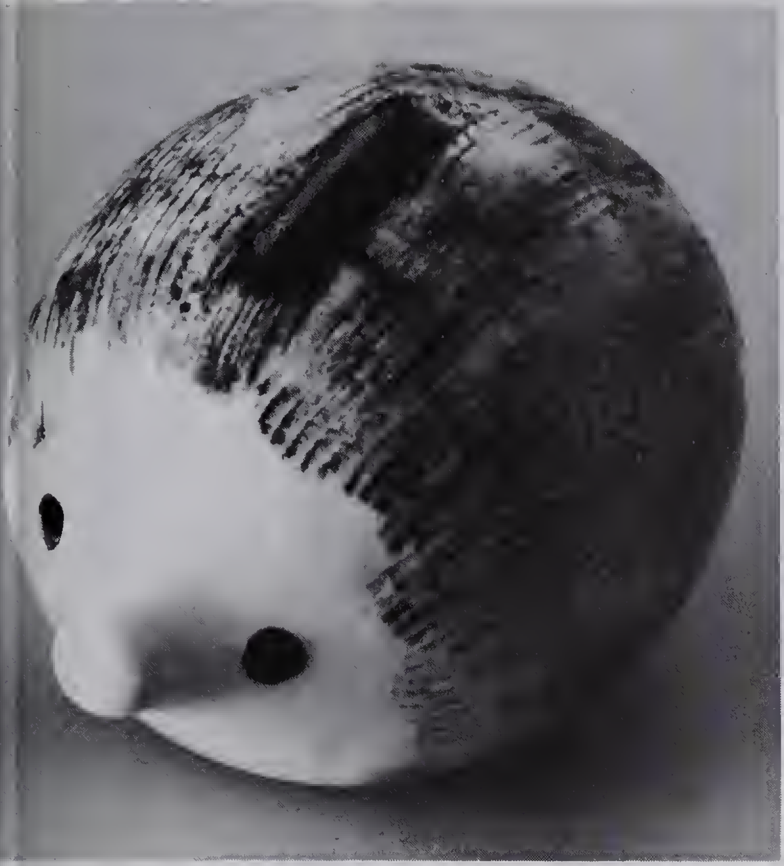
If the shape of an article made of glass is such that it makes us think it has been for instance carved, or if it does not allow the light to bring out the character of glass, some other material would probably have done the job much better. So before we judge an object like a wine glass we must consider that it was produced by the most delicate force imaginable, human breath, acting on a delicate pliable material, which sets in the form of a transparent skin.

Here are three toy animals. One was made of glass, **4**, one of clay, **3**, and the third of wood, **5**. The glass animal certainly makes the most of its material – we can almost see how the craftsman made it. It suggests glass as soon as you look at it and could not have been made in any other way or of any other material. The pottery animal also makes the most of its material. Full round shapes are best in pottery, as too many sharp corners may give trouble in the firing. You can see that the potter has been successful in combining the

2



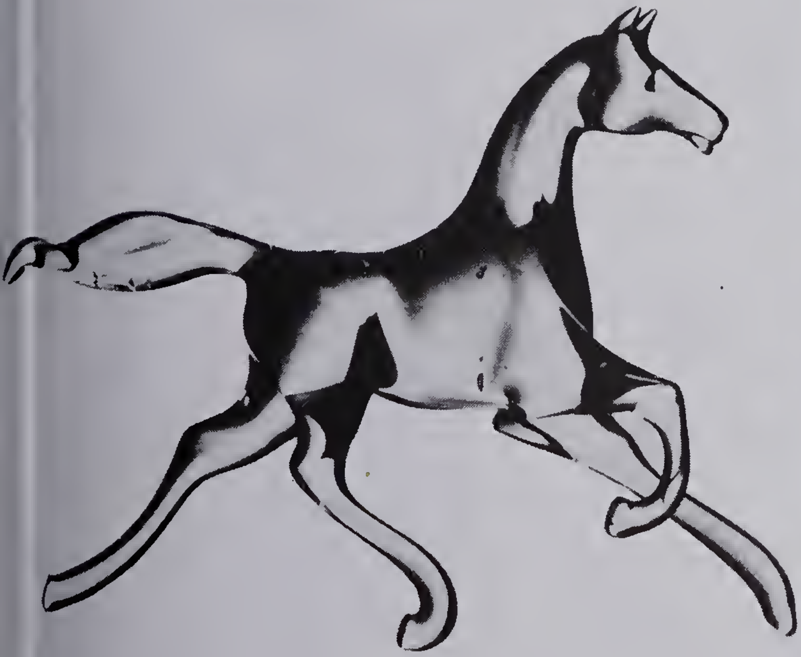
roundness of pottery shapes with the roundness of the hedgehog. Both are natural. He has also scratched the top part to convey the roughness of the real animal. The wooden animal is of course quite different. It is carved, and again the material has played an important part in the formation of the shape. Wood does not lend itself to the delicate shapes of glass, nor does it produce the wonderful surfaces of pottery; it has its own character. The shape of the cow has a certain "woodiness" and the grain fits the shape. This craftsman, too, has used his material to help him in the creation of his shape. These three toy animals are good shapes because the craftsmen who made them were very much aware of the materials they were using and used all their skill to produce forms suited to their materials. Can you imagine a glass animal made in the shape of the wooden one? The character of the material would no longer bear any relation to the shape.



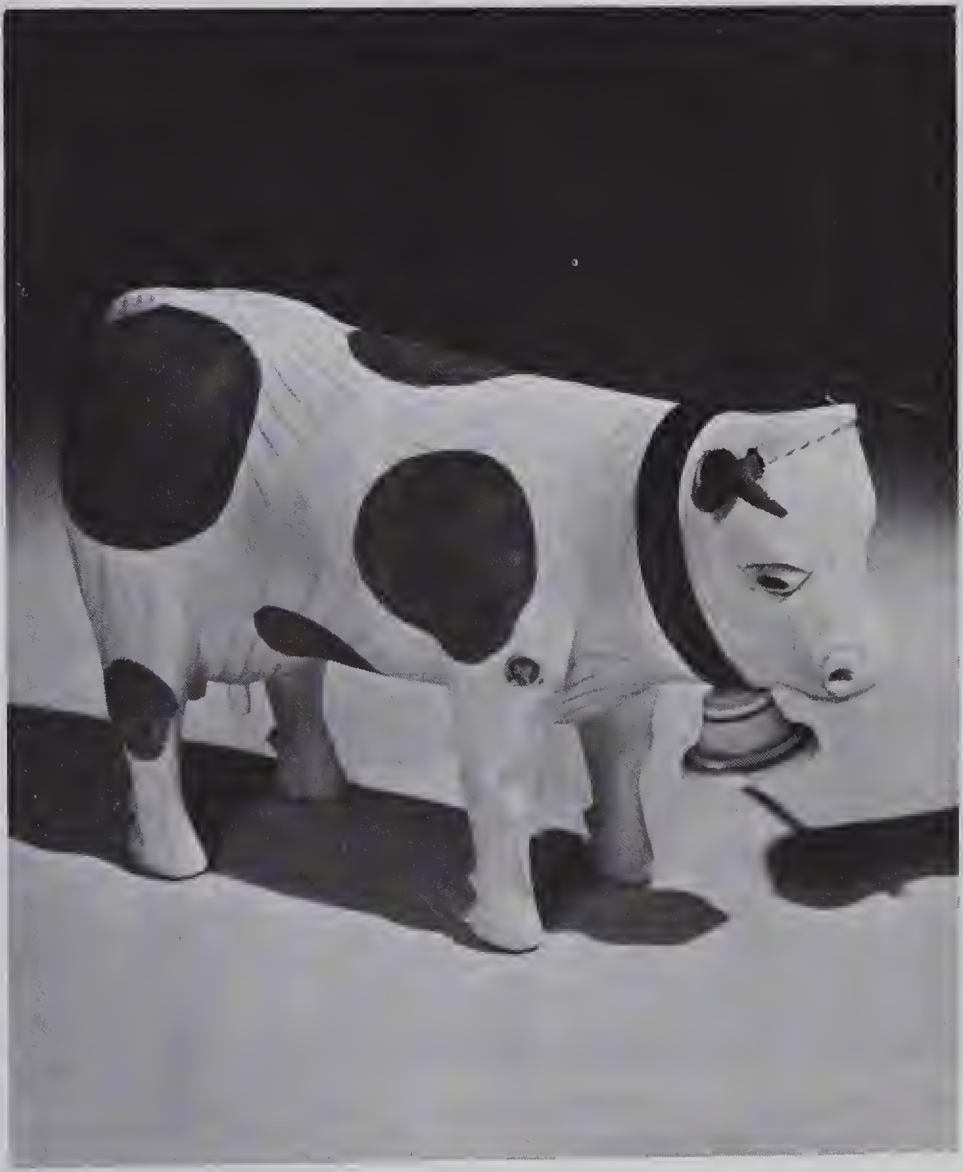
3

4 5

3, 4, 5. *These toy animals show up the different characteristics of the materials quite clearly.*



1. *Casting on the stem of a wine glass*
2. *How a glass animal is made. The craftsman makes use of the characteristics of the material and the final shape reflects these characteristics.*



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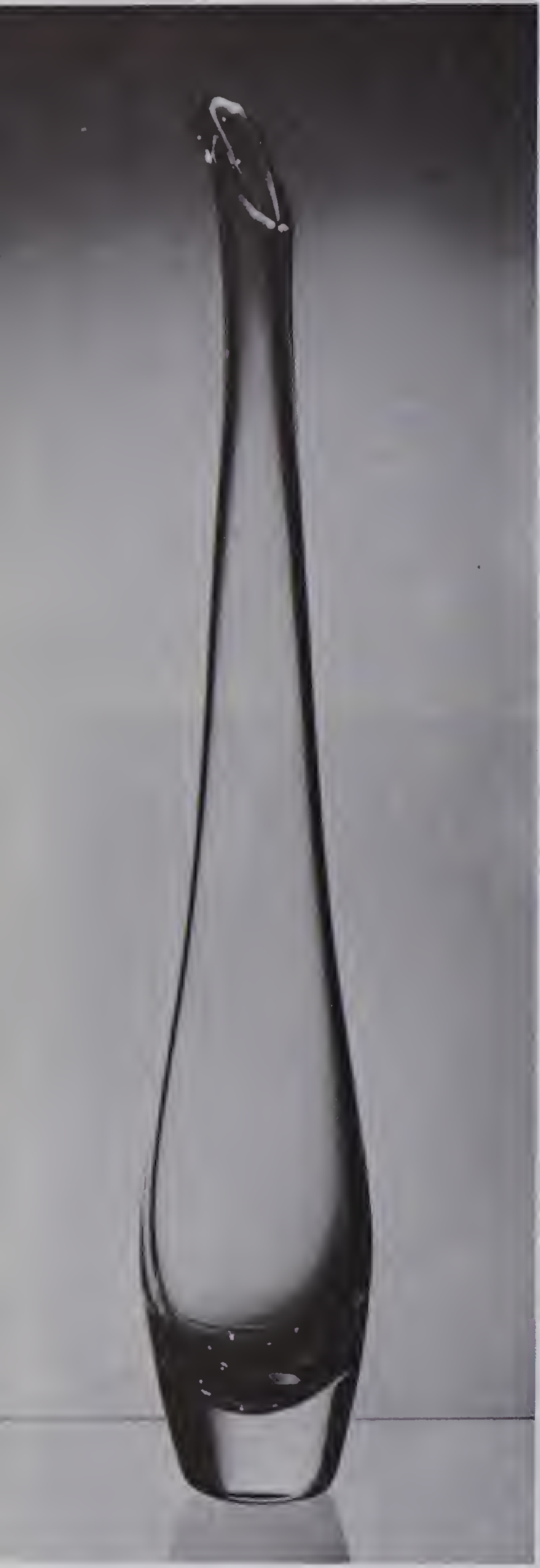

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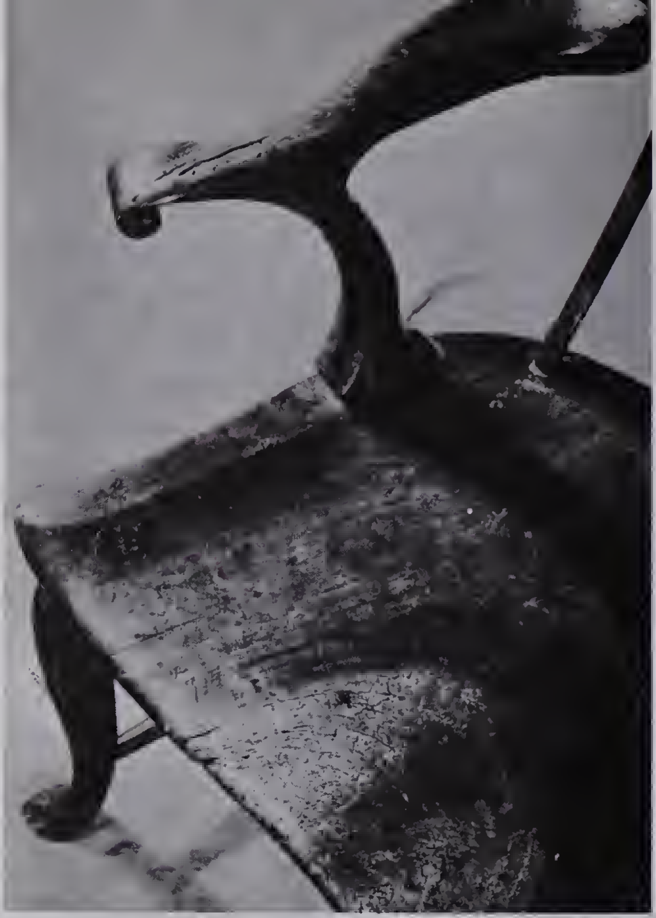
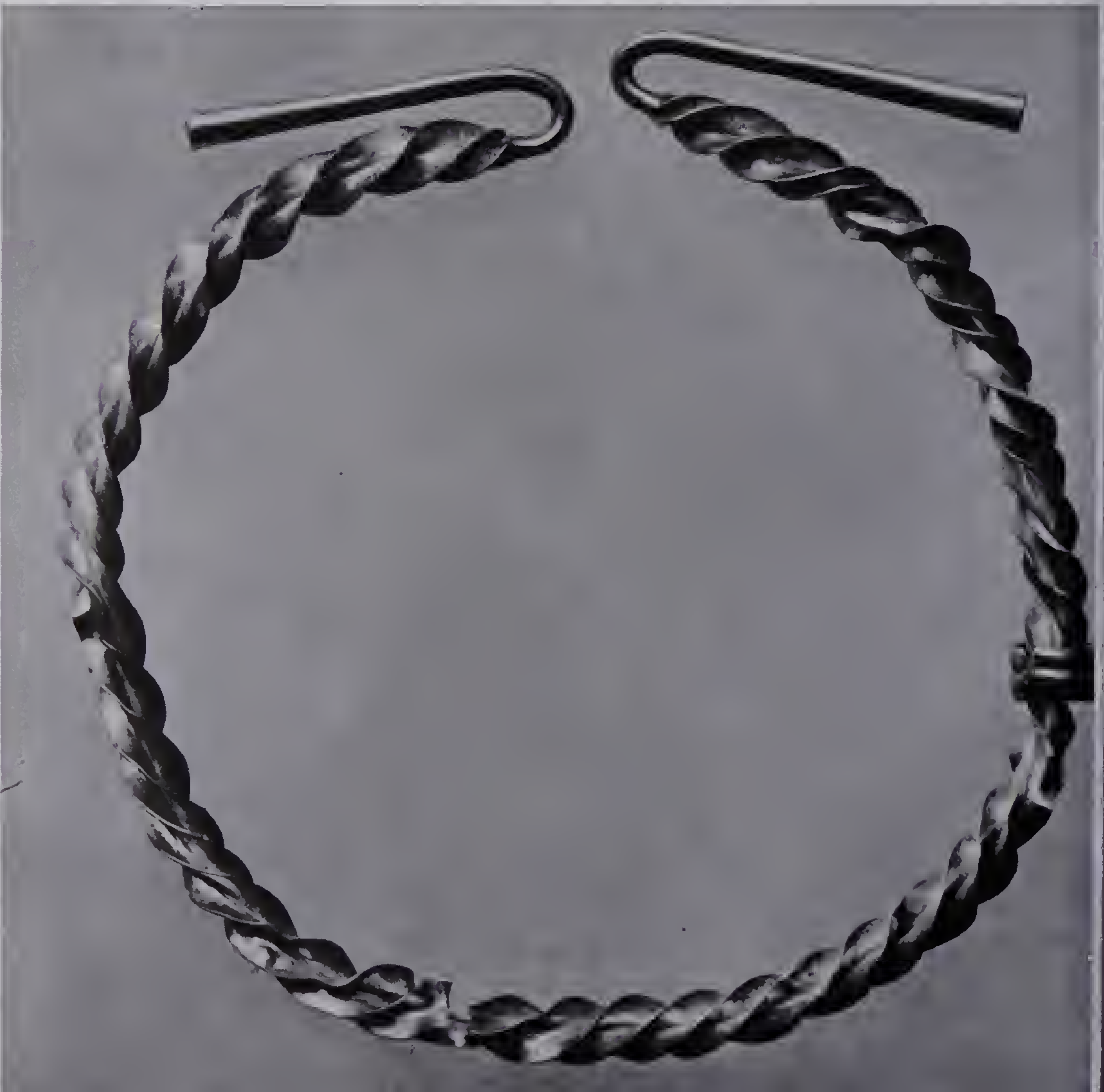
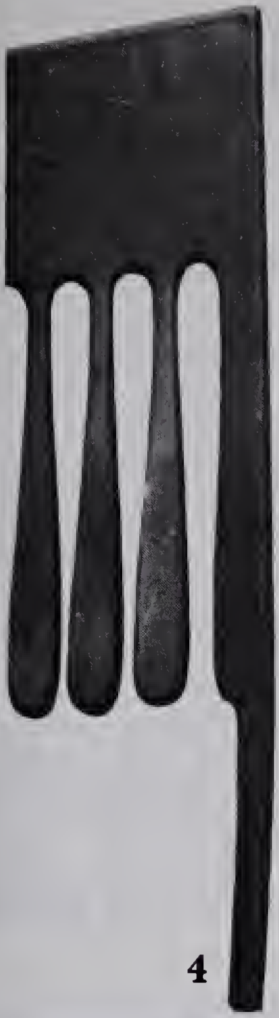


The shapes in pictures **1** to **3** are suited to their materials, and each one seems to express the way in which it was made. They are, of course, not the only good shapes for these materials; many more, equally in keeping with the character of the material, can be made.

3



1. *A glass vase* **2**. *A wooden chair*
3. *A bronze torc (necklet)*



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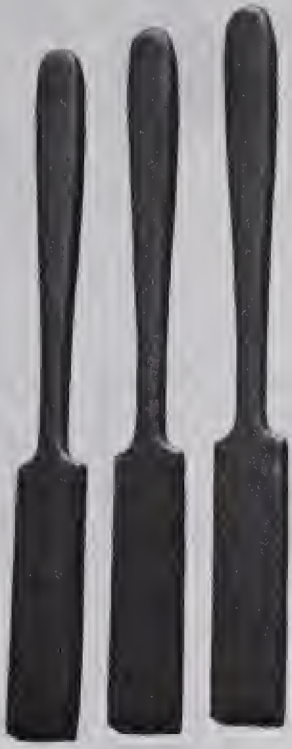

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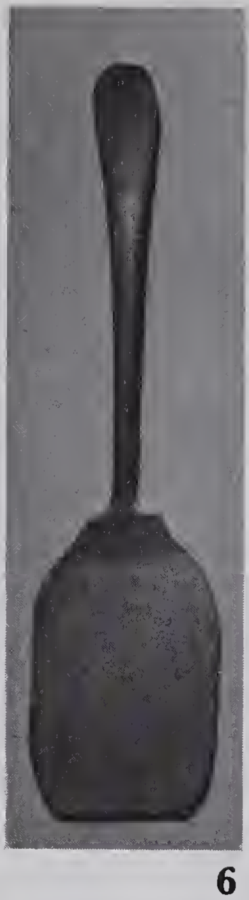

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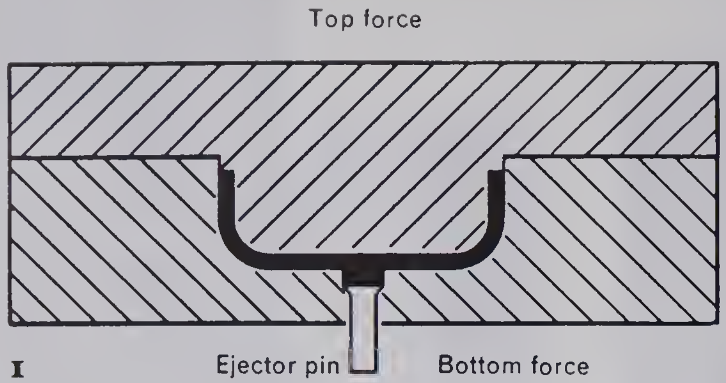
Pictures **4** to **9** show some of the stages in the manufacture of a spoon. First, the basic shape, **5**, is stamped out of a sheet of stainless steel, **4**. The tip, which will eventually become the bowl of the spoon, is rolled repeatedly until it is the required size, **6**; then it is cut to shape, **7**, and pressed and polished, **8**. Many intermediate processes, such as the curving and thickening of the handle, are not shown here. There are two interesting points to think about. If you look at the piece of metal left over after the basic spoon-shapes have been stamped out, **4**, you will see that it provides another row of identical shapes, so that only a very small piece of material is wasted. The shape of steel cutlery is largely determined by reasons of economy; each piece must be so shaped that as little material as possible is wasted in its manufacture. The second point is that the repeated rolling makes the metal not only thin but also hard, and this hardening occurs at the place where it is most needed. The basic shape, therefore, is a direct result of the method of manufacture, and this method produces an efficient finished shape. We can see very clearly the close relationship between the shape of the spoon and its method of manufacture.

9. *How a spoon is rolled*



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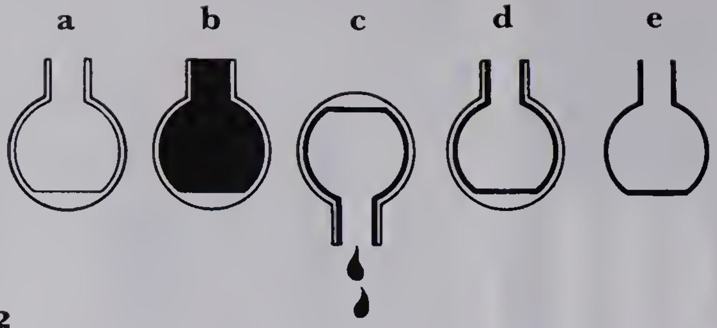

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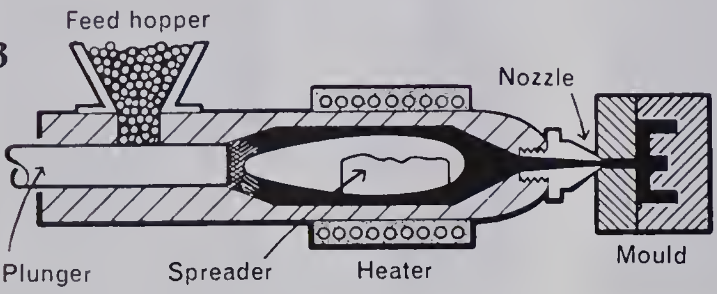

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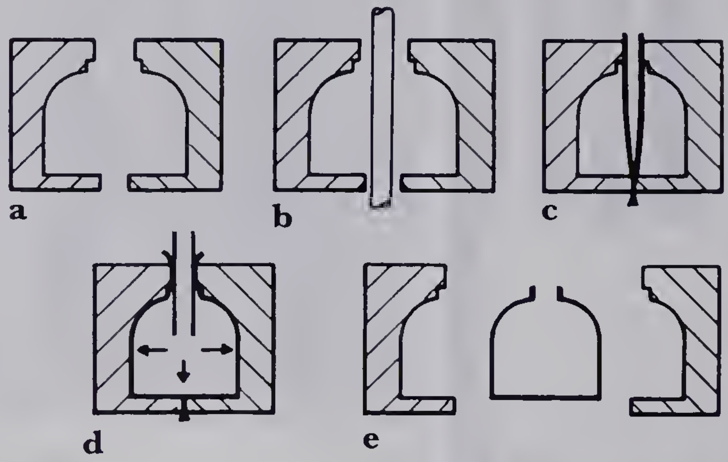
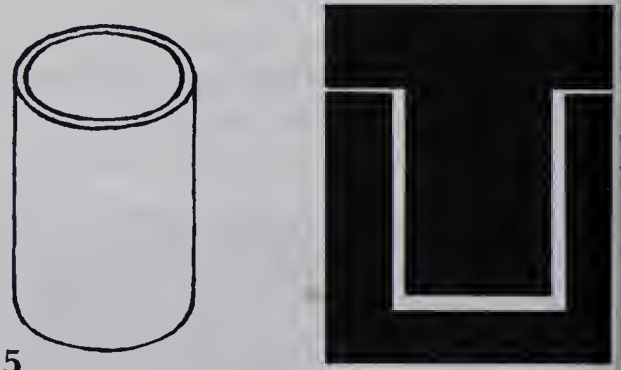


We cannot, then, understand and appreciate a shape until we know something about the material of which it is made and the way in which it is made. The glass horse does not mean much to us until we realise that it is made of glass. This also applies to modern materials. We cannot properly judge objects made from plastics unless we know something about their manufacture.

Diagrams **1** to **4** show some of the methods used to shape plastics into useful objects. All have their advantages and disadvantages. For instance, **2** and **4** can never produce walls of an entirely uniform and accurate thickness, but these are efficient and cheap methods where high precision does not matter. Injection moulding, **3**, is mostly confined to the manufacture of smaller objects, for in making larger ones the material tends to cool before it has reached the farthest point. Better quality plastics, melamines for example, which are used for good table-ware and kitchen utensils, can be processed only by compression moulding, **1**. Such high quality plastics not only wear better than cheaper varieties but they are also pleasanter to touch and handle and are heavier in weight.



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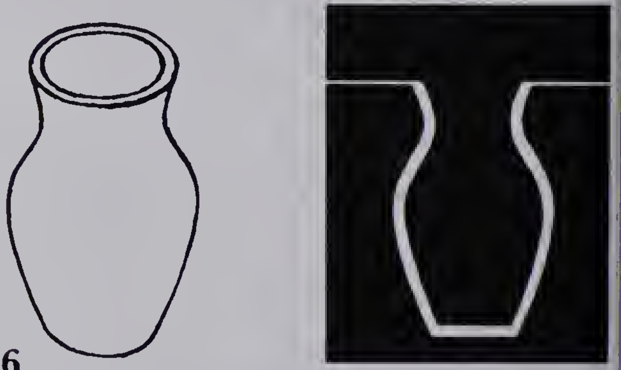

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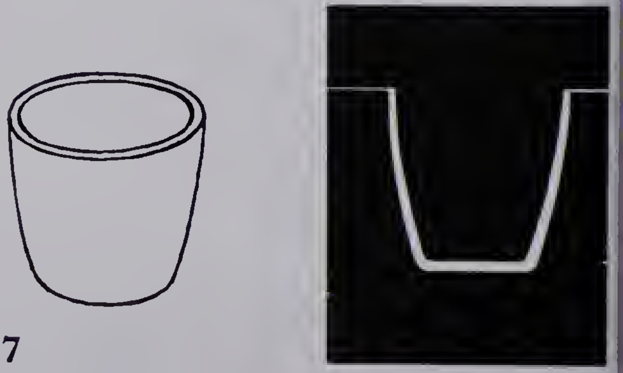

7

1. Compression moulding: shaping a powder in a hot mould under pressure
2. Casting: (a) empty mould, (b) mould filled with plastic, (c) mould emptied, (d) setting of plastic layer, (e) finished product
3. Injection moulding: the material is softened by heat and injected into the closed mould under great pressure.
4. Blow moulding: (a) open heated mould, (b) length of plastic tube inserted, (c) mould closed, (d) air blown into tube expands it until it meets the mould, (e) mould opened

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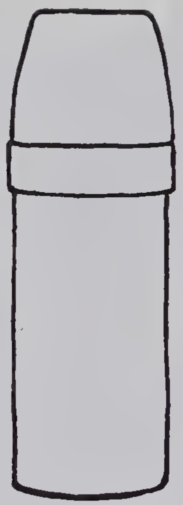
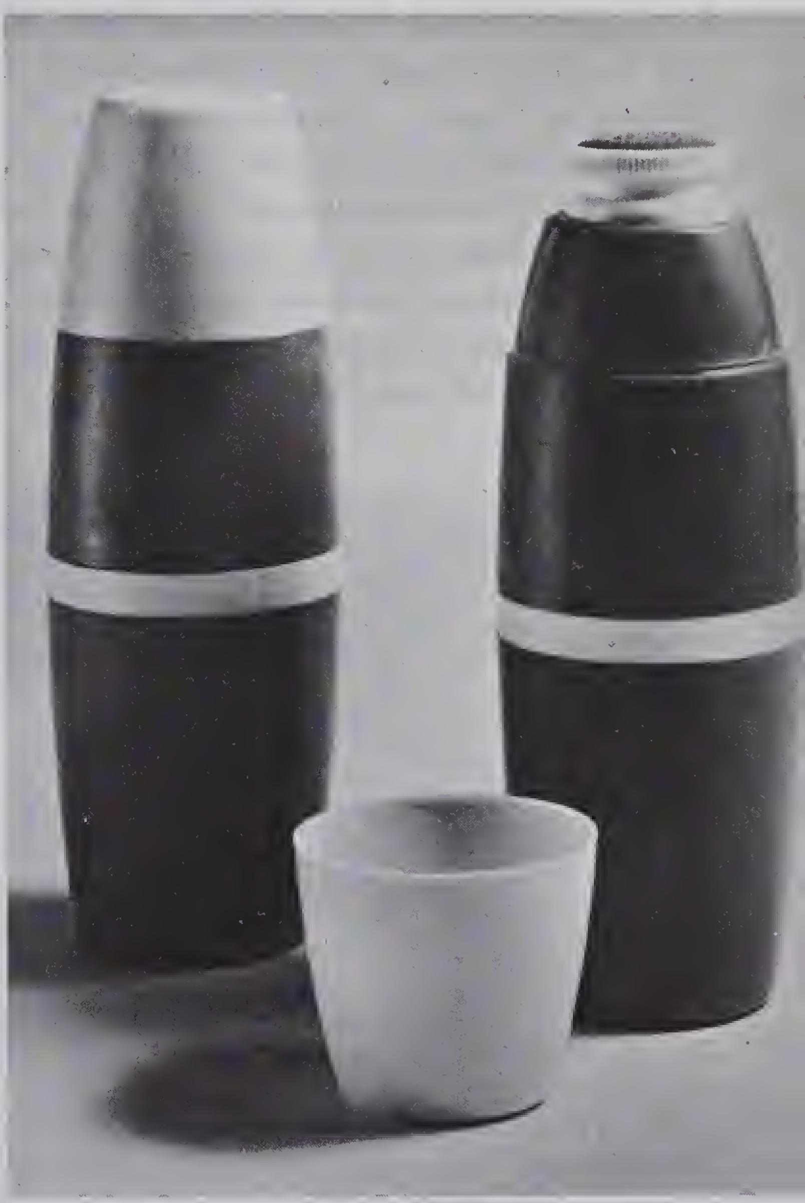


9

After studying diagrams **1** to **4** you will realise that a vessel with straight sides, although it can be made of plastic, is not an ideal shape for such material as it will cause friction when the moulds are parted, **5**. A vase-like shape with a narrow neck is impossible to make by compression moulding, as you can see from a comparison of diagrams **1** and **6**, but it can be made by some of the other processes. A beaker of the shape shown in diagram **7**, wider at the rim than at the base, is a good plastic shape. It allows the moulds to part quite easily; the rounded off corners make the actual moulding easier; and, because of its curvature, it is extremely strong. Another point to understand is that plastic warps and becomes distorted as it sets. The curvature of **7** is calculated to counteract this distortion.

The outer case of the vacuum flask in picture **8** consists of two distinct parts, one made of plastic and the other of metal, and the shape of each reflects the way in which it was made. Sometimes vacuum flasks are made of plastic throughout but still the square shape of the metal is imitated, **9**. The designer of such flasks has failed to solve the problem of using his materials to the best advantage. The vacuum flask shown in picture, **10**, on the other hand, is a true plastic shape and makes use of all the best features of this material. Because this designer has understood the character of the material a screw-on cap has become unnecessary and a snap-on cap takes its place. The plastic stopper is leak proof. The flask can be dropped onto hard surfaces without damage. All these benefits are achieved by designing a shape which fits the character of the material.



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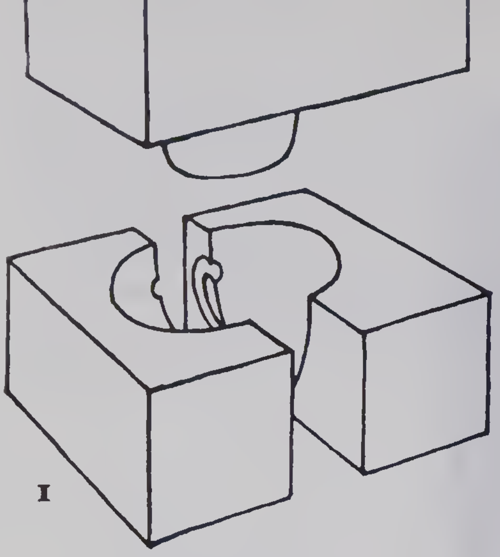

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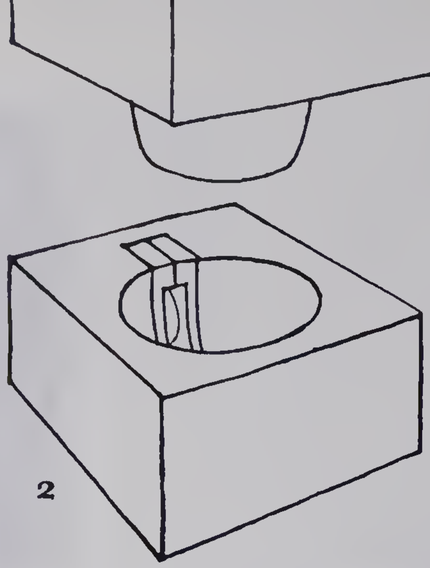
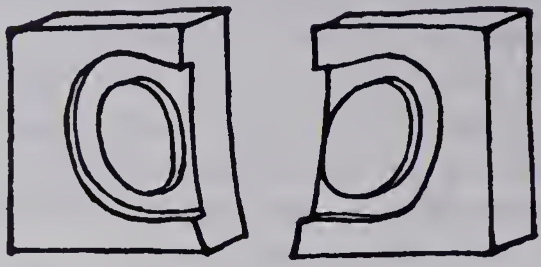


2

Two methods of dealing with a handle **1**. *Split mould. This leaves a flash line on the outside of the cup.* **2** *to* **4** *show another method. Separate moulds for the handle,* **3**, *have to be inserted into the main mould,* **2**, *by hand, and removed, again by hand, from the finished product,* **4**. *This is cumbersome and also leaves marks on the outside of the cup.*

So far we have thought only about plastic vessels without handles, but what happens when a handle is added to such objects? This of course complicates the whole process, because a cup, at least the kind of cup we are accustomed to, cannot be moulded in one clean operation. As you can see from pictures **1** and **2**, a cup handle gets in the way no matter how the mould is split. Pictures **5** to **10** show how the shape of the cup handle, as we know it, was arrived at over thousands of years. We can see that it is a typical pottery shape, perfectly suited to its material and its purpose. For a long time such traditional pottery shapes, for want of a true understanding of the new material, have been imitated in plastics, in spite of the difficulty of producing them and the resulting unsatisfactory appearance.



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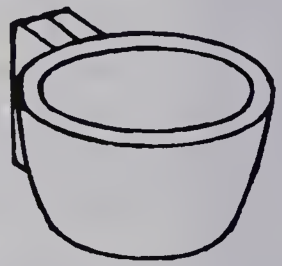

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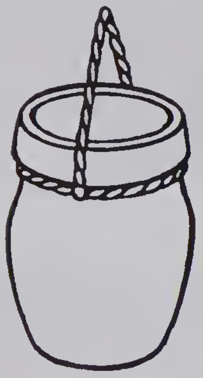

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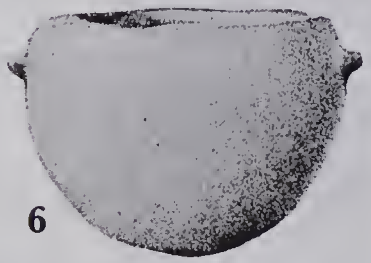
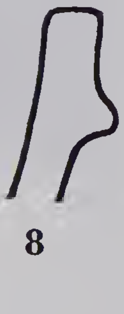


6

7

The development of the pottery handle Early vessels were carried with the help of a rope held in position by a rim, **5**. *Lugs later replaced the rim,* **6**; *they were pinched out of the soft clay,* **8**. *Larger lugs had to be stuck on,* **9**, *and were eventually pierced to stop the rope from slipping off,* **7**, **10**. *These eventually became handles, used without the rope. Even today pottery handles are still added to the basic cup-shape by hand,* **11**.



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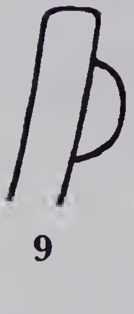

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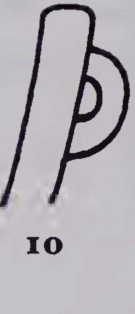

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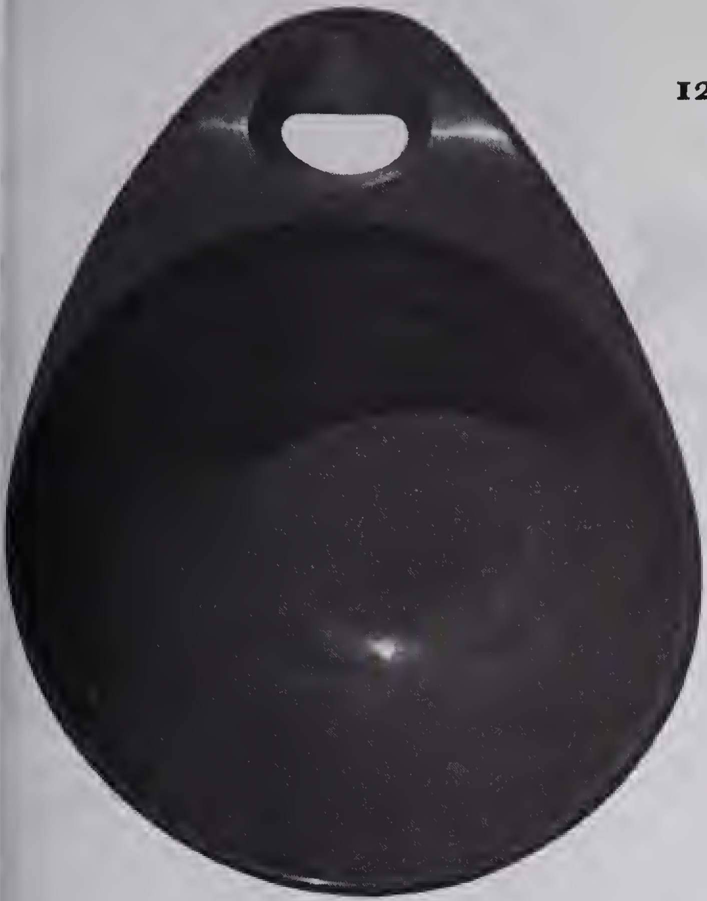

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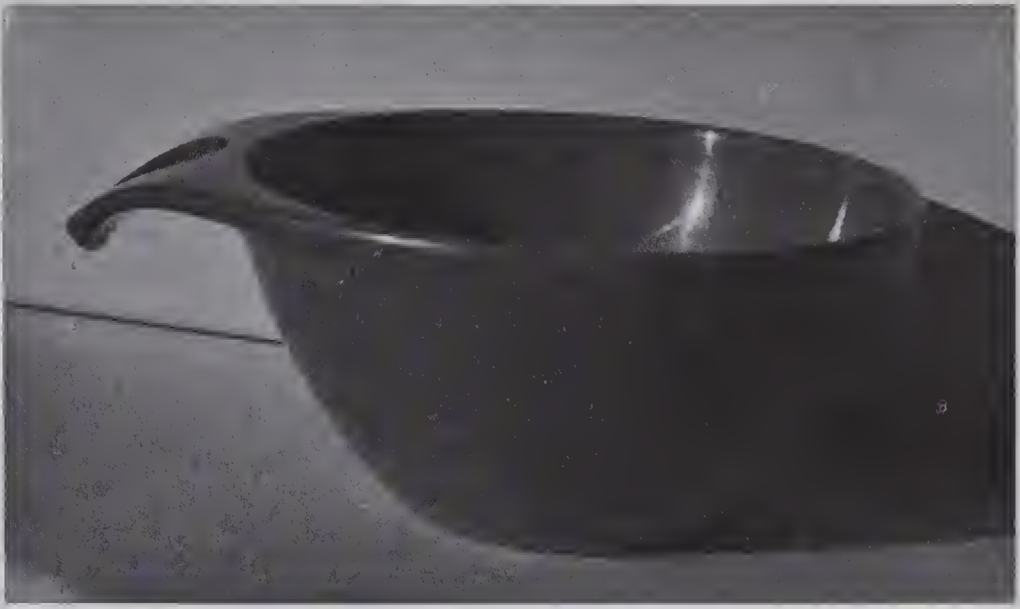
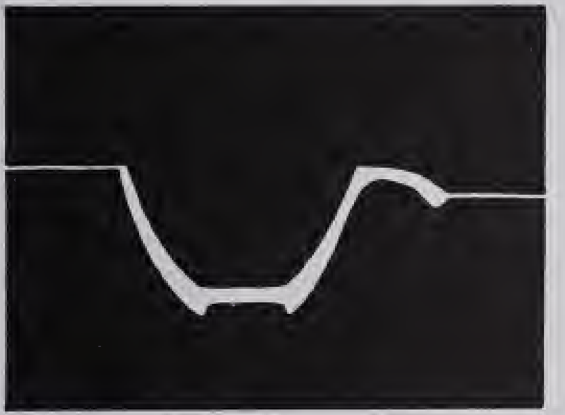


As designers of plastic objects have gained more experience, however, they, like the early tool-makers, have devised new shapes suited to the new material. This cup, **12**, **13**, is one such shape. The diagram, **14**, shows how it was made, and you can see that there is no flash line anywhere on it. The cup is one whole solid shell and extremely strong. A new material has caused the creation of a new shape which is as pleasant from the user's point of view as it is practical from the maker's. There is a relationship here between material and form which was totally lacking in earlier plastic cups. They were imitating a form which properly belongs to pottery; the new cup is a true plastic shape.



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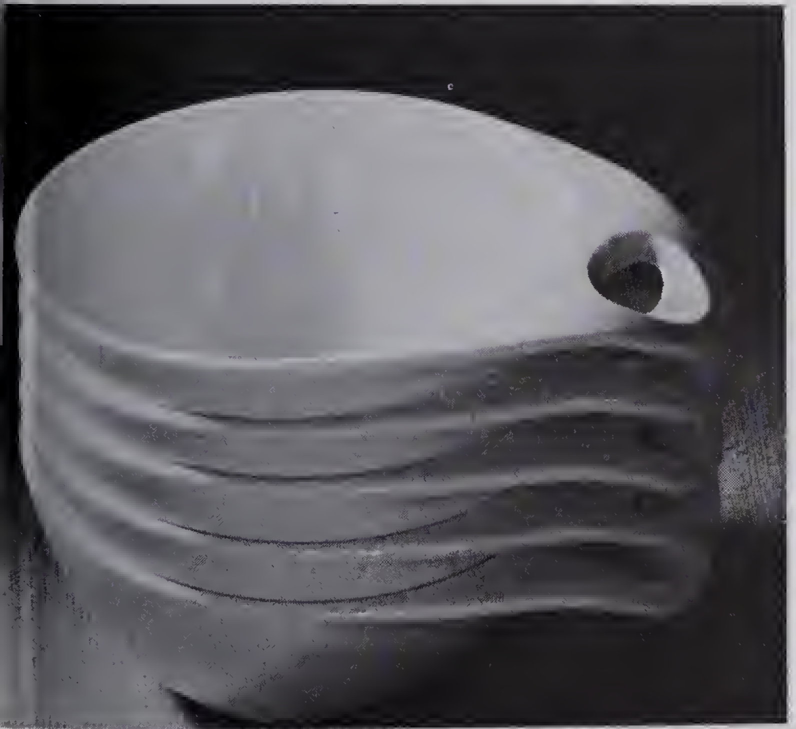

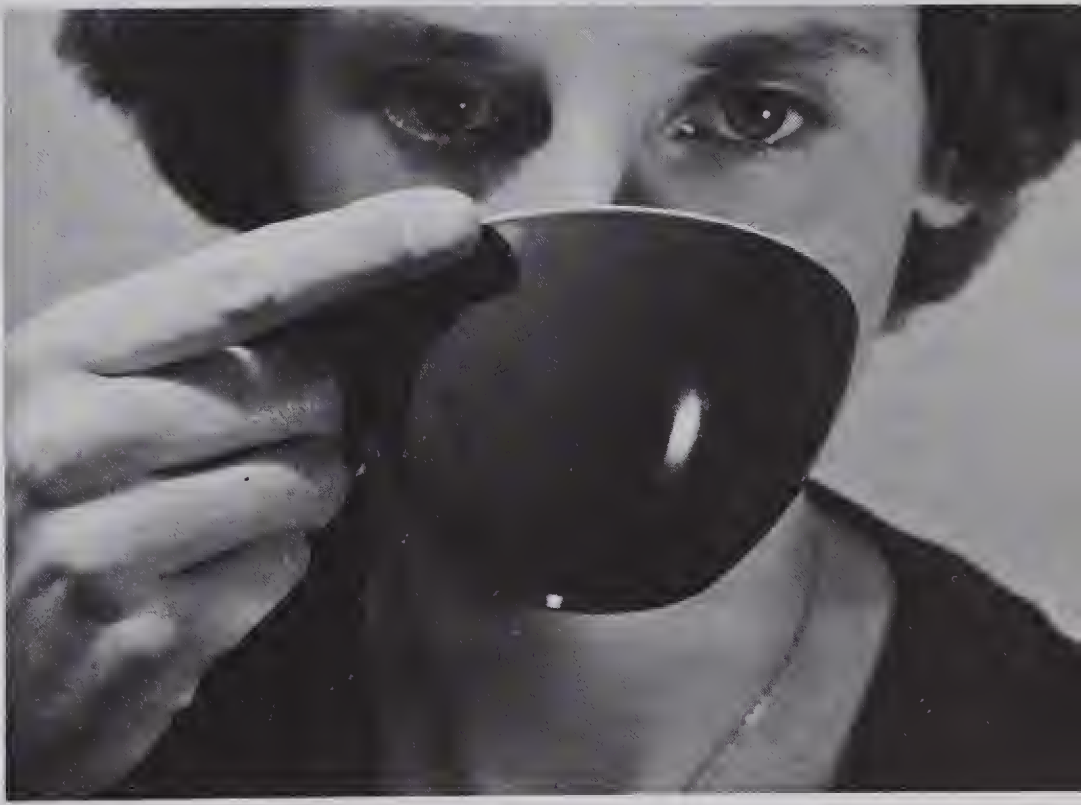

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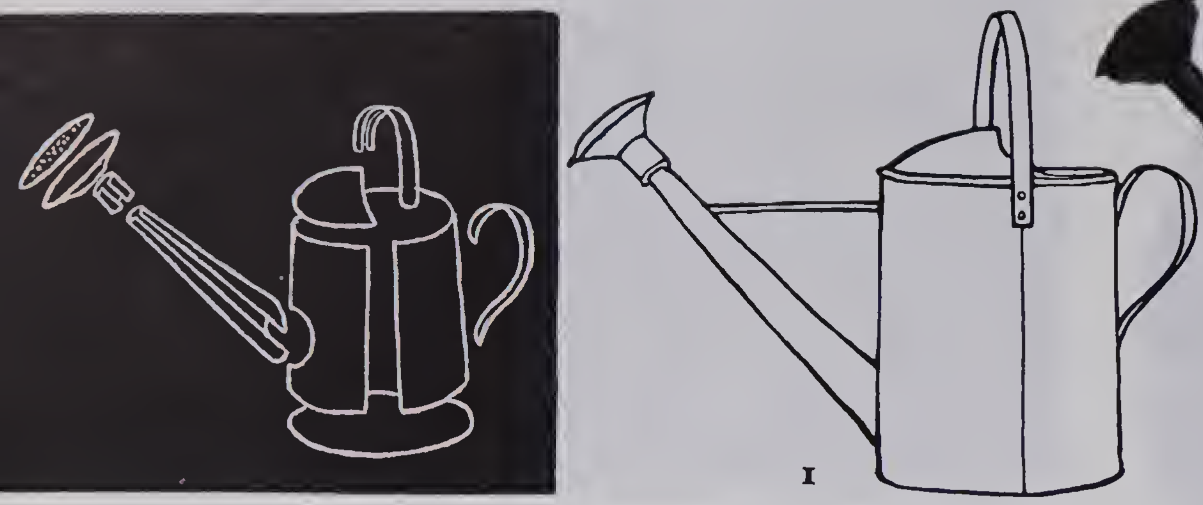
One of the advantages of the new plastic cups is that they can be stacked. Although the new handle must be grasped in a new way, most people find it more convenient than the old, once they are used to it.



1

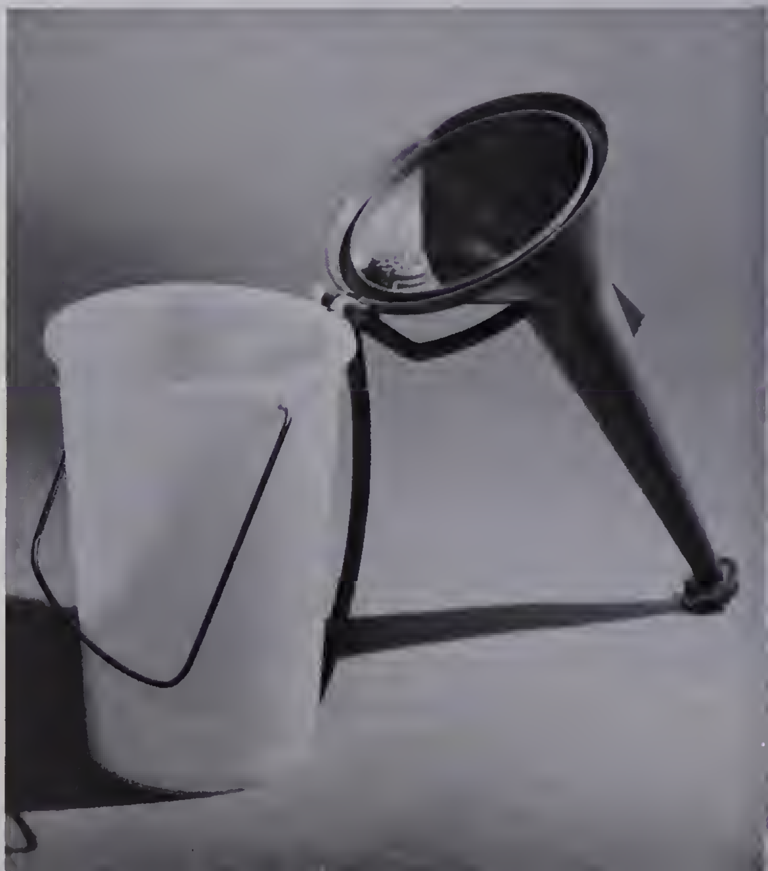
2

Picture **1** shows a watering can. This type has been made of sheet metal for many generations. You can see here how such a can was made and how each part corresponds to a manufacturing process. It is an honest shape in relation to the materials used and to the method of manufacture. When plastics were first used for watering cans, the traditional metal shape was imitated, just as the first bronze celt imitated a stone shape. The shape of this plastic watering can, **2**, follows very closely the form of the metal can, yet both the material and the process of manufacture are different. The metal can is made of different pieces of sheet metal, jointed and put together, while the plastic can is moulded. Picture **3** shows an attempt to turn the character of the new material to good use.

As in the case of the cup, a new watering can shape, **4** and **6**, has eventually been created for the new material. It is strikingly different from the earlier watering can shape. But if you study pictures **4** and **6** you will soon understand that it is a shape suited to its material and at the same time practical and efficient; it, too, is a true plastic shape.

As they gain knowledge of their material, designers are devising new shapes for many more plastic objects. Because plastic can be moulded into thin, almost wafer-like walls which are at the same time strong, it is possible to depart from traditional forms. The roundness we associate with mugs and cups is determined by the potter's wheel. There is no point in imitating these shapes unless they suit the character of

3



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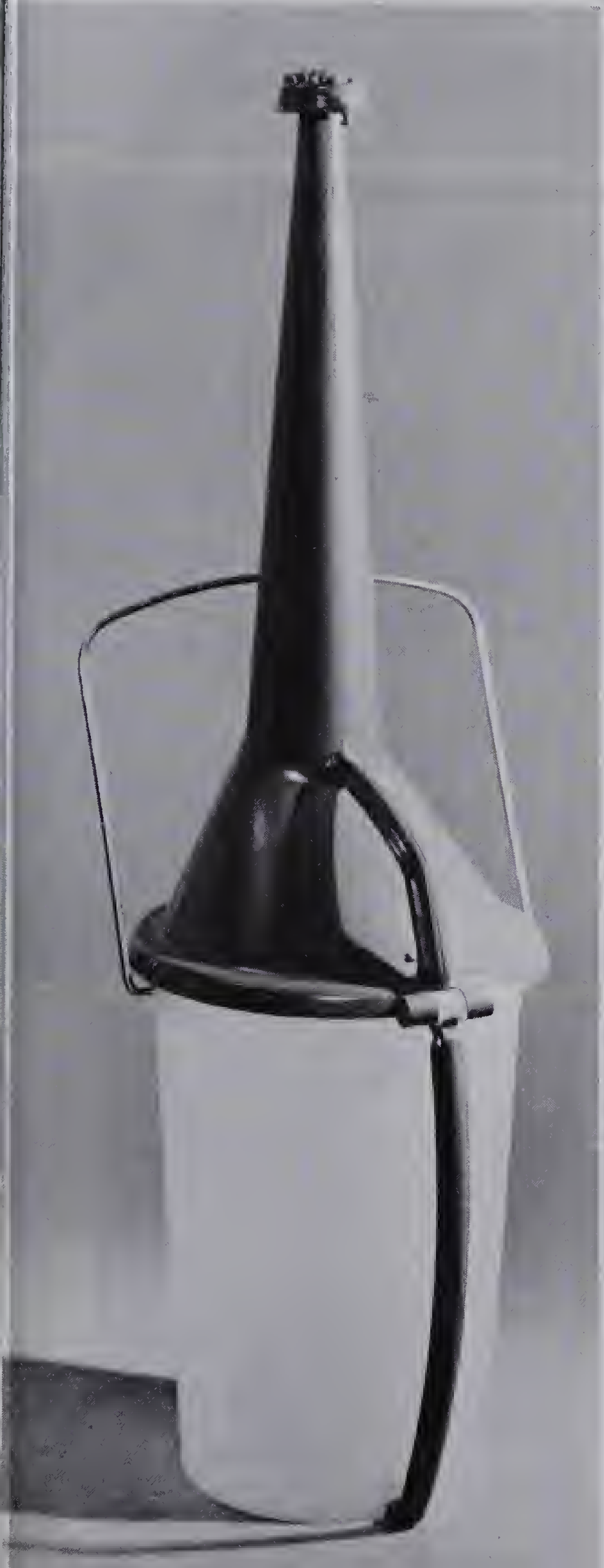
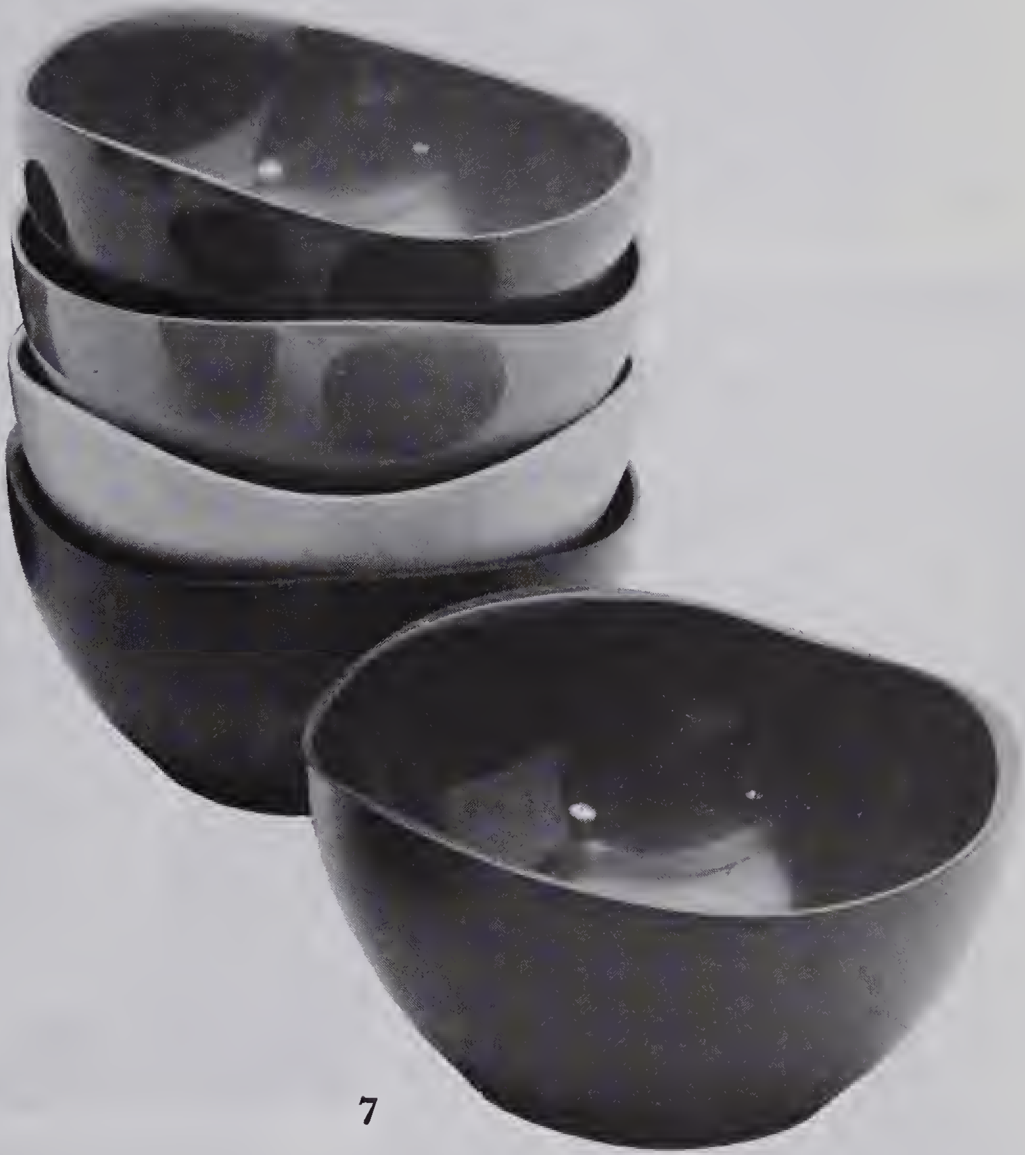


6

the new material. The plastic jug, **5**, and the plastic bowls in picture **7** have unfamiliar forms because they were moulded, and the designer has used the moulding process to the best advantage. You can see from the pictures on this page as well as on pages 22 and 23 how a material can determine its own shapes. The new shapes are bringing with them a number of advantages, just as the changes in the shapes of the early tools made them more efficient. Can you think what these advantages are?



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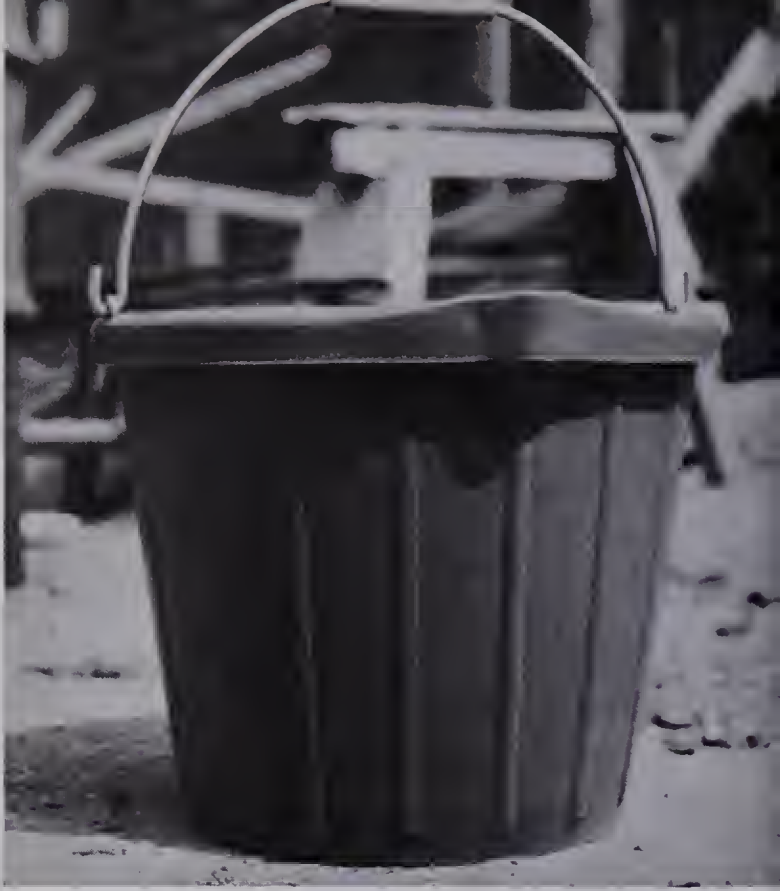
6. *The plastic watering can has a greater reach than ordinary watering cans. It does not splash when in use and can be taken apart for easy storage. The bottom part may be used separately, as a bucket,* **4**. *The plastic bowls will not jam together when stacked, because of their varying thickness.*

We have seen that to judge the shape of plastic objects we must have some idea of how they are made. Next time you go into an ironmonger's shop, look at the plastic objects on sale, the tea strainers for instance. Try and make up your mind which are imitations of older metal forms and which have tried to create new forms by breaking their ties with sheet metal, wire mesh and wire.

Good plastic shapes. **1**. *A plastic bucket The ridges serve as reinforcements.*
2. *A plastic camera* **3**. *A plastic basket Notice that the designer has not attempted to imitate real basket work.* **4**. *A plastic razor* **5**. *A number of light switches incorporated in one plastic shape* **6**. *A photographic safe light with interchangeable body*

1



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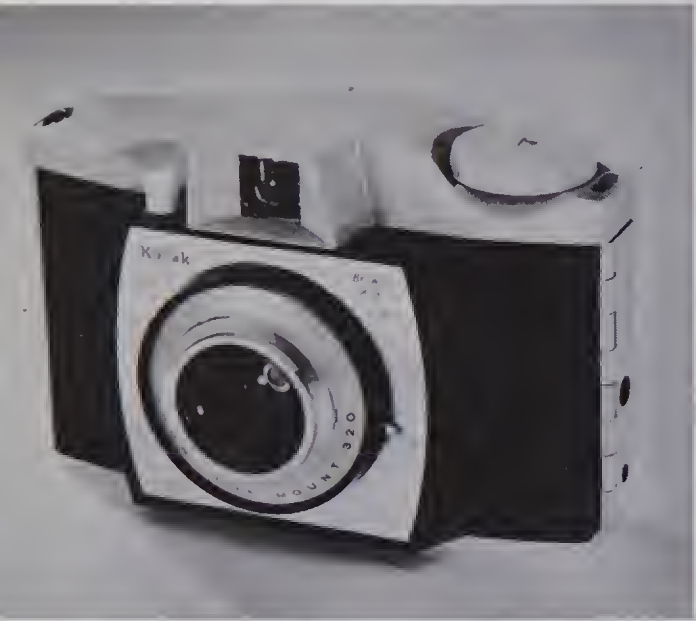

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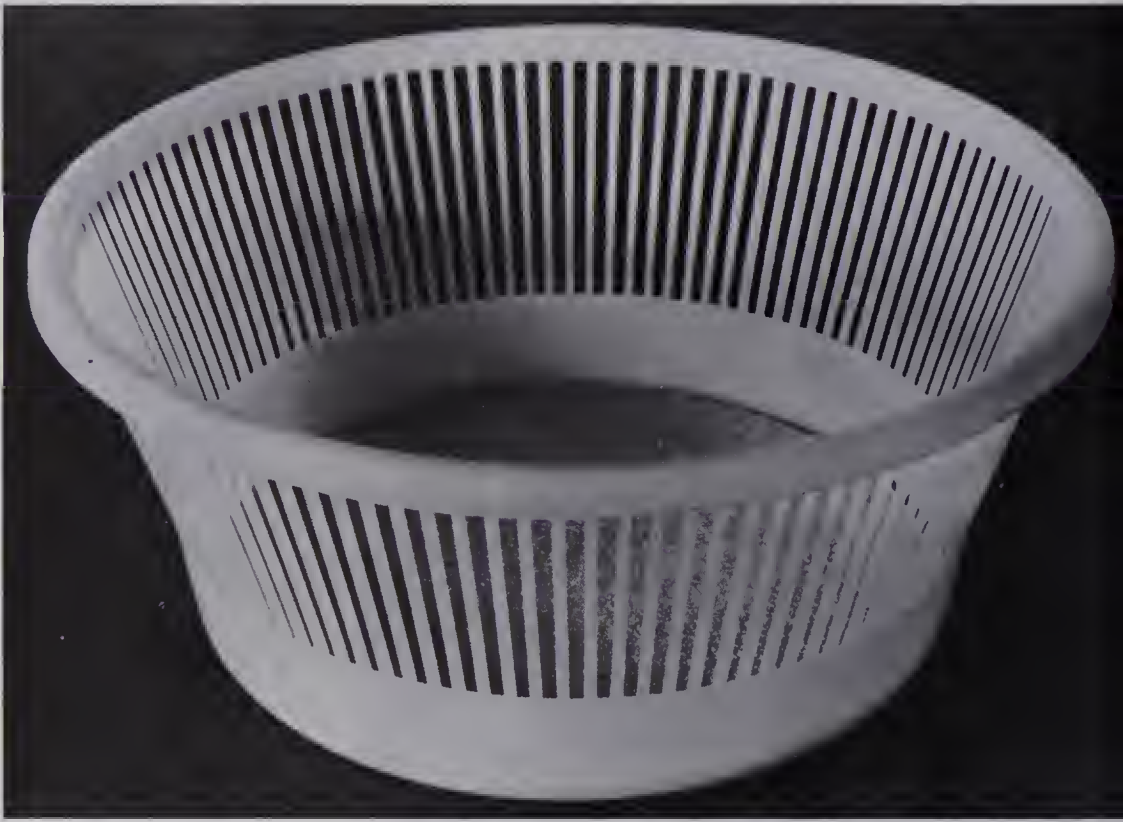

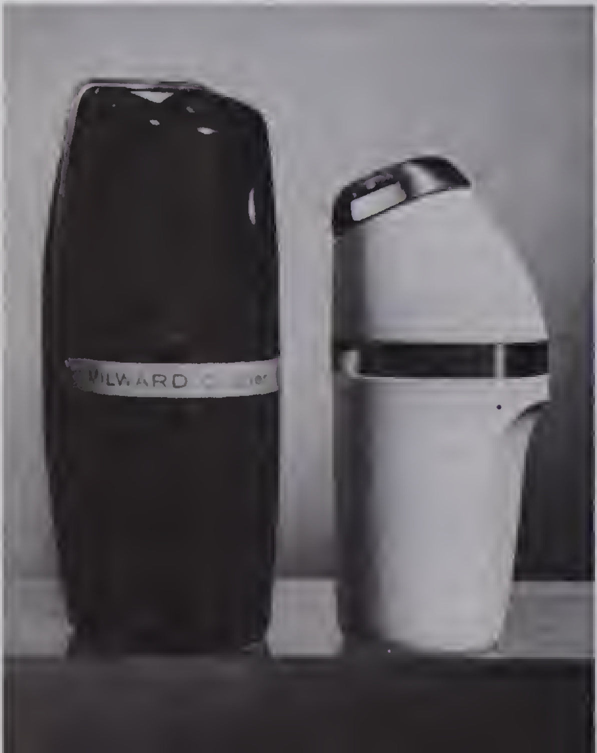

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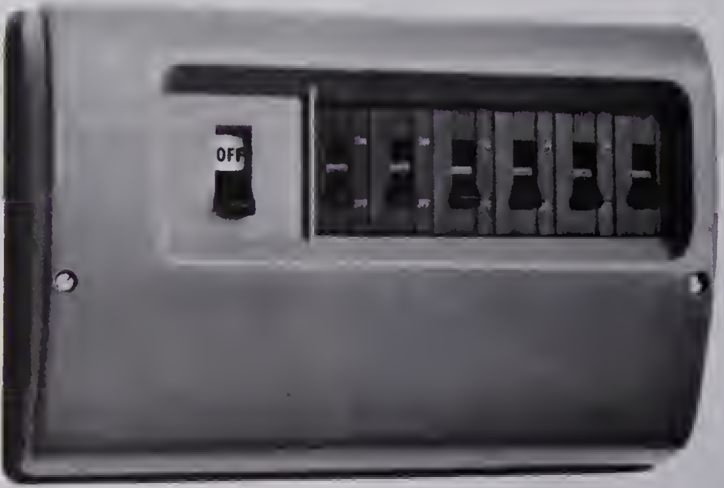

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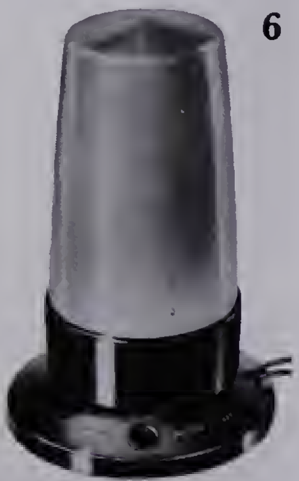

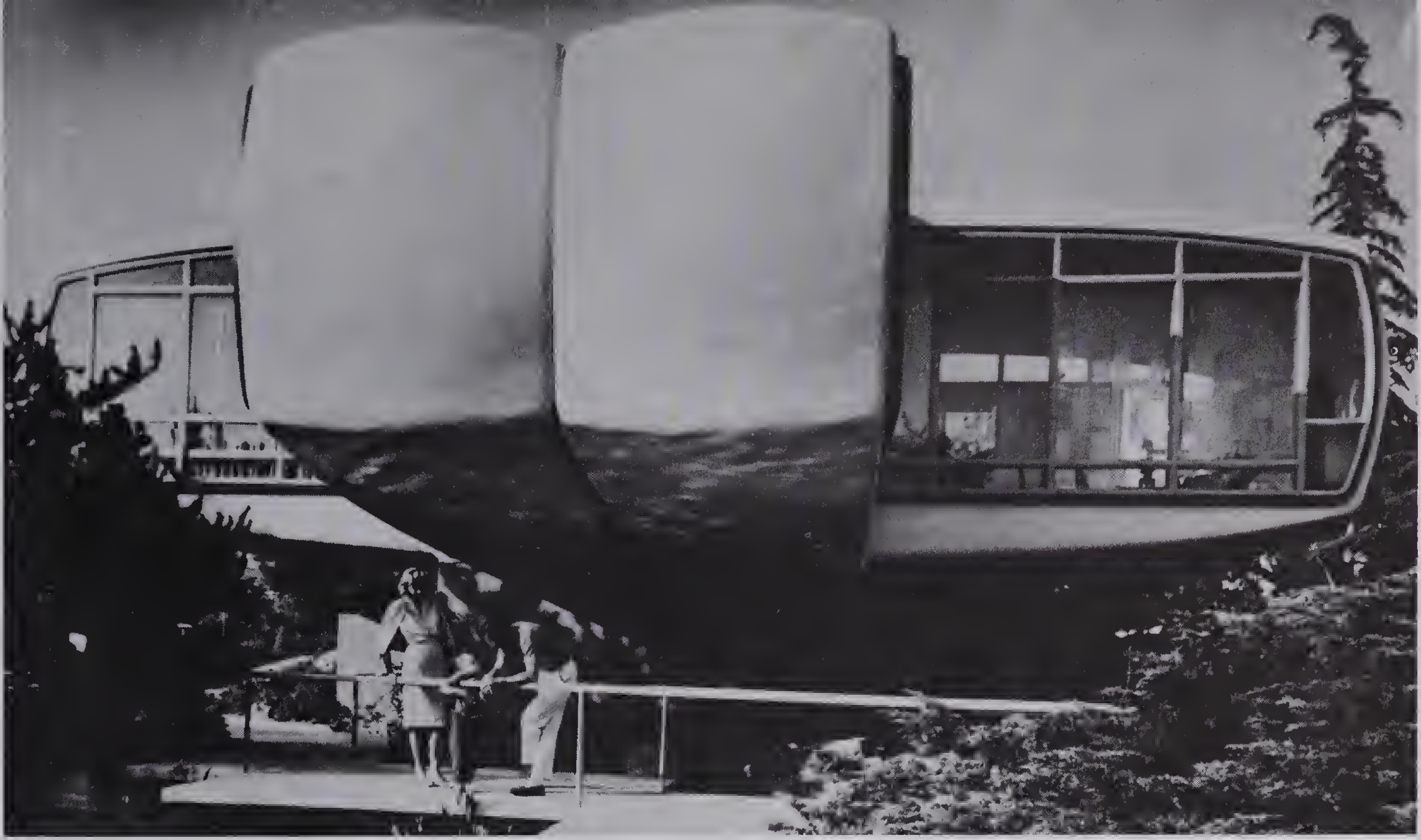

7

The first steps are being taken in experimenting with various plastics for building. This experimental house, **7**, shows that if plastics come into use for building they are likely to transform the shapes of our houses. This house was assembled from pre-fabricated sections, **10**, and these sections had to be of a shape to give the greatest possible strength to the shell of the house. Many fittings, such as the wash basin, **9**, which are also made of plastics, have assumed new shapes because of the character of the material. This house is only a first step. Perhaps the plastic houses which may one day be built in our towns and villages will be even more unusual in shape. As designers gain more and more understanding of the new material, they will create shapes which will allow the new way of building to reach its highest efficiency.

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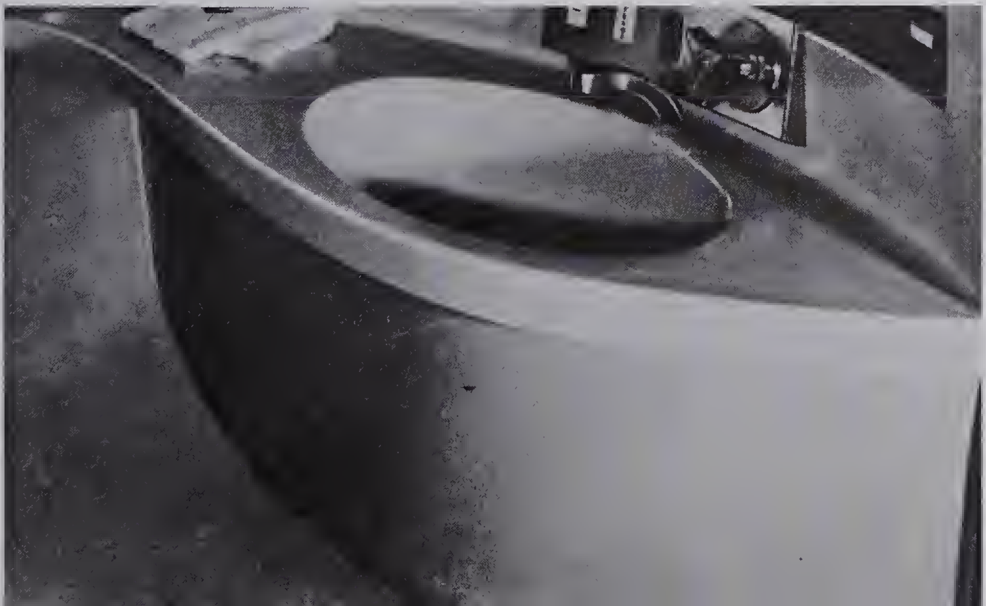

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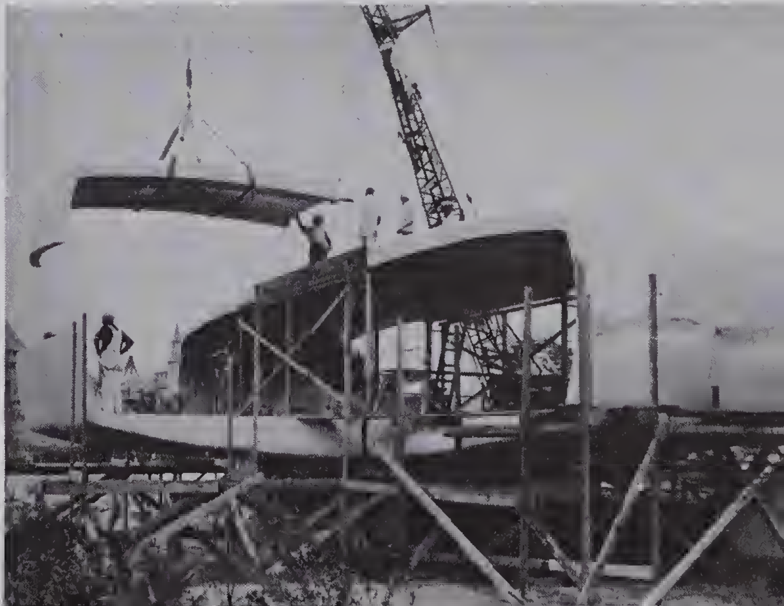
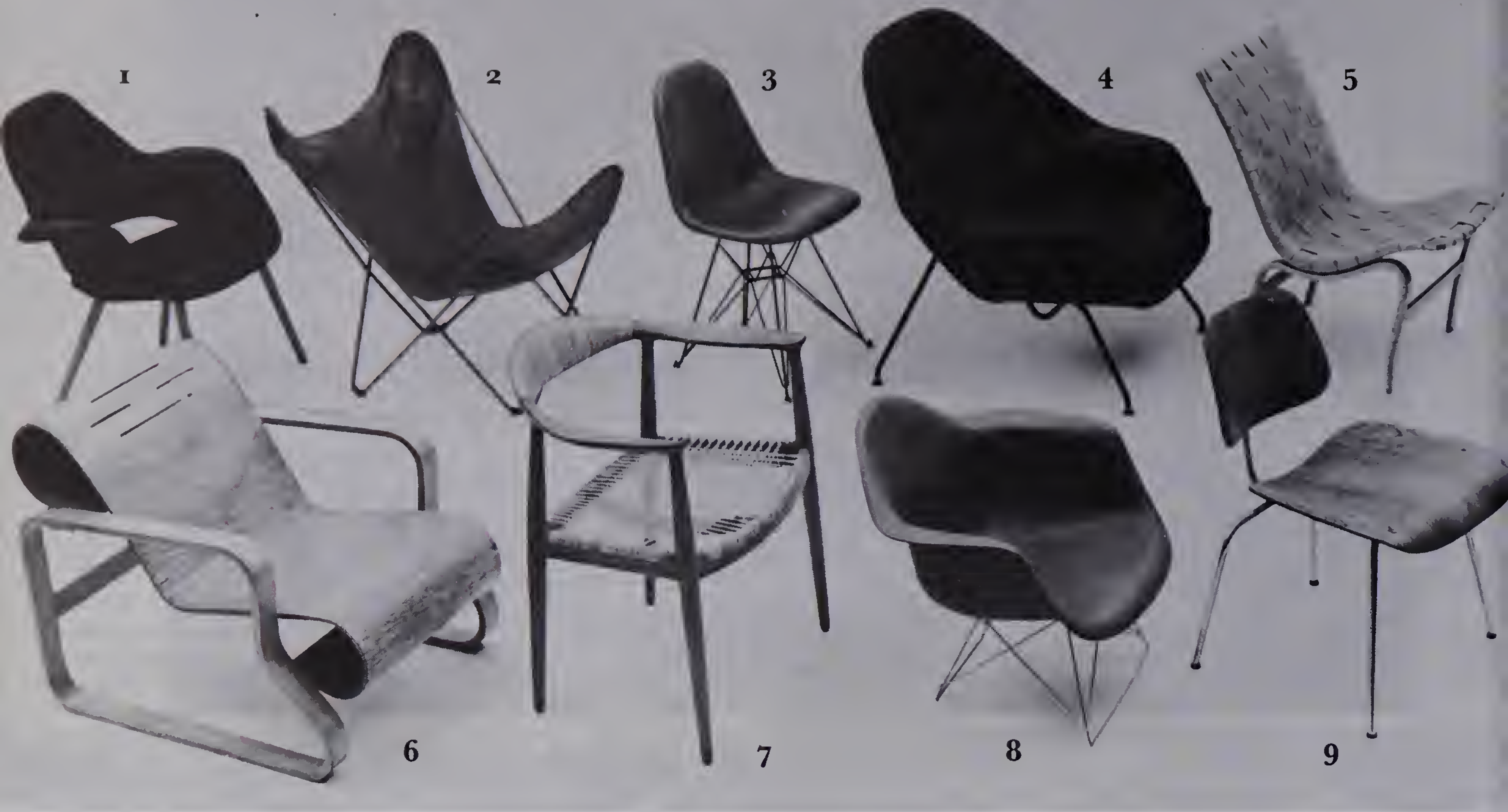
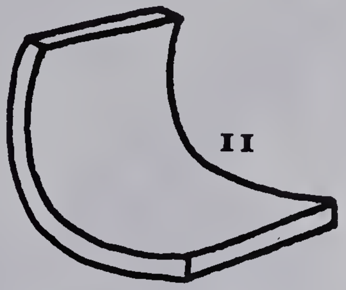




10

Study these chairs in detail. They are different from each other because they are made of different materials, and in each case the designer has arrived at a form which makes efficient use of his material. Not only is the seat of each chair a different shape, but the legs also vary considerably because different constructions were necessary. Why do you think the plastic chair, **10**, has only one central leg? Try and decide which are the advantages and disadvantages of each chair. The chair made from laminated plywood, **6**, looks the least comfortable and therefore the least successful, although its construction is very ingenious and makes use of the strength and springiness of the material. Plywood is a strong and at the same time light material. Its disadvantage is that it can be bent in only one direction in any place. The seat of chair **9** is made of moulded plywood and seems to curve in two directions, but the two curvatures are not in the same place. The wood and metal chair, **14**, is even more ingenious. It is made from a single piece of plywood cut to a special shape and drawn in at the sides so that a curved shell results. The thin supporting pieces between seat and back are very

1. *Armchair in moulded plywood with sponge rubber.* **2**. *Chair in metal and leather* **3**. *Chair in leather and metal wire* **4**. *Armchair in moulded plastic and foam rubber* **5**. *Chair in laminated wood and canvas webbing* **6**. *Armchair in laminated and bent plywood* **7**. *Armchair in wood and woven cane* **8**. *Armchair in moulded plastic and metal wire* **9**. *Chair in moulded plywood and metal rods* **10**. *Chair in reinforced plastic*



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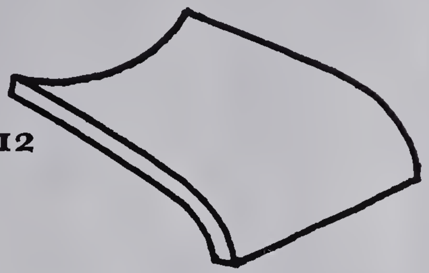

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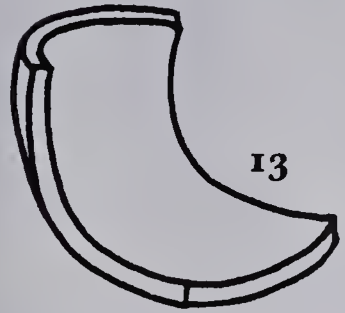

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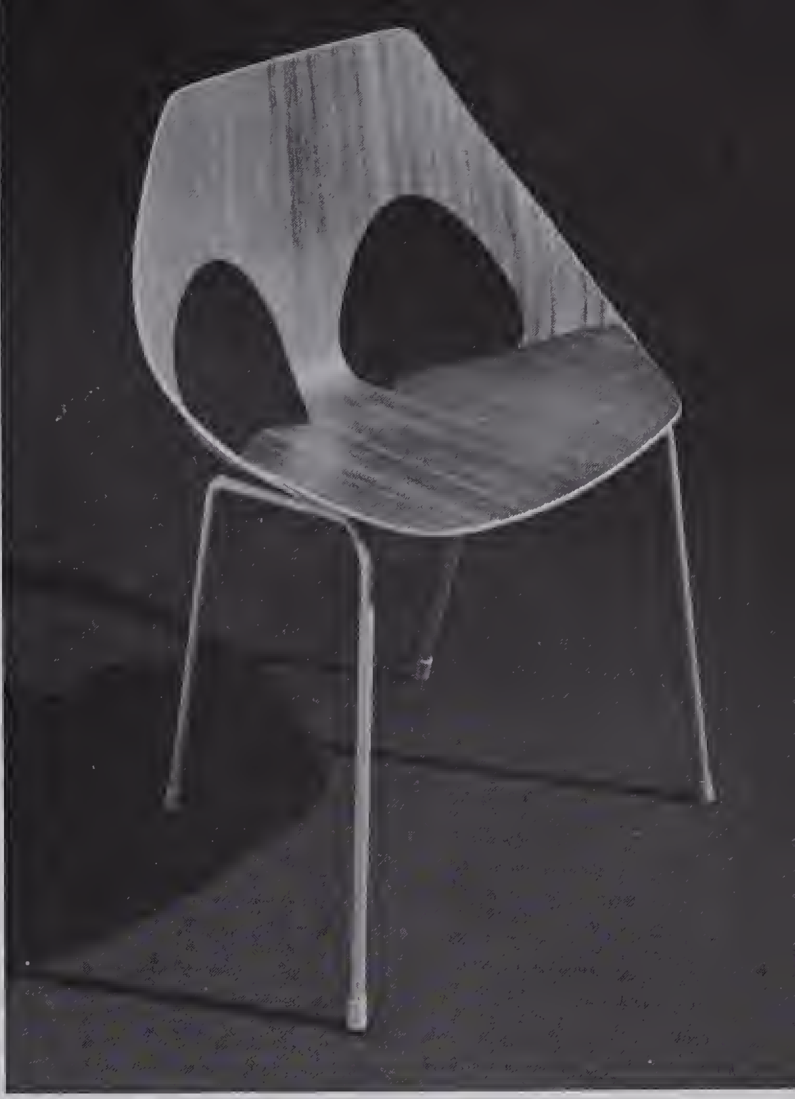
Plywood can be bent as in **11** *or even* **12**, *but not as in* **13**. *Fibreglass, on the other hand, is capable of being formed into continuously curving shapes,* **15**. *The fibreglass chair,* **16**, *is a natural outcome of its material and process. This is the chief reason why it varies from the wooden chair,* **14**.



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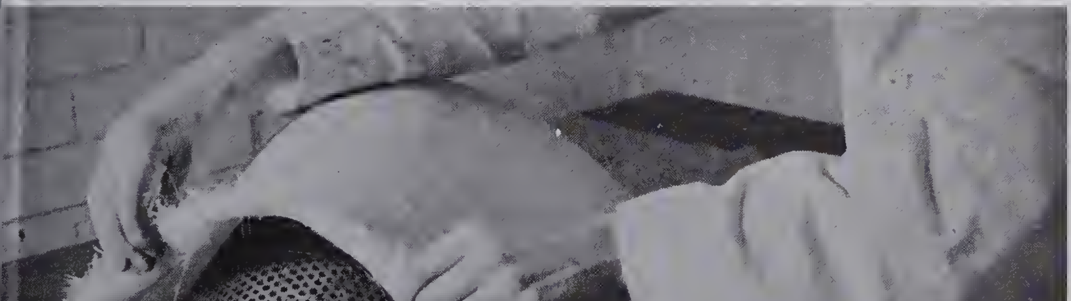
springy and yet strong enough to support an occupant without breaking. This chair gives the impression of a smoothly and continuously curved shape, which indeed it is, but nowhere is there more than one simple curvature in the same place. Because the designer has mastered his material he has given us an interesting shape.



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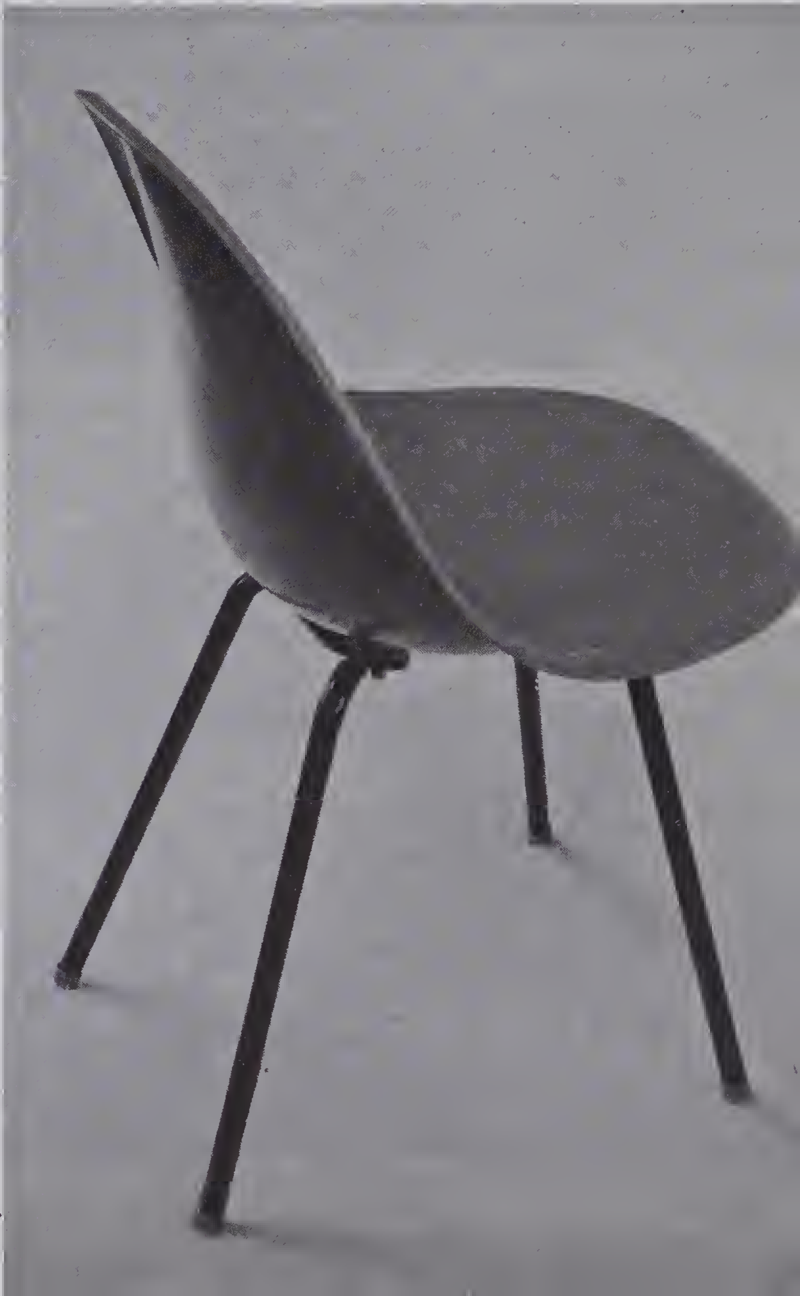

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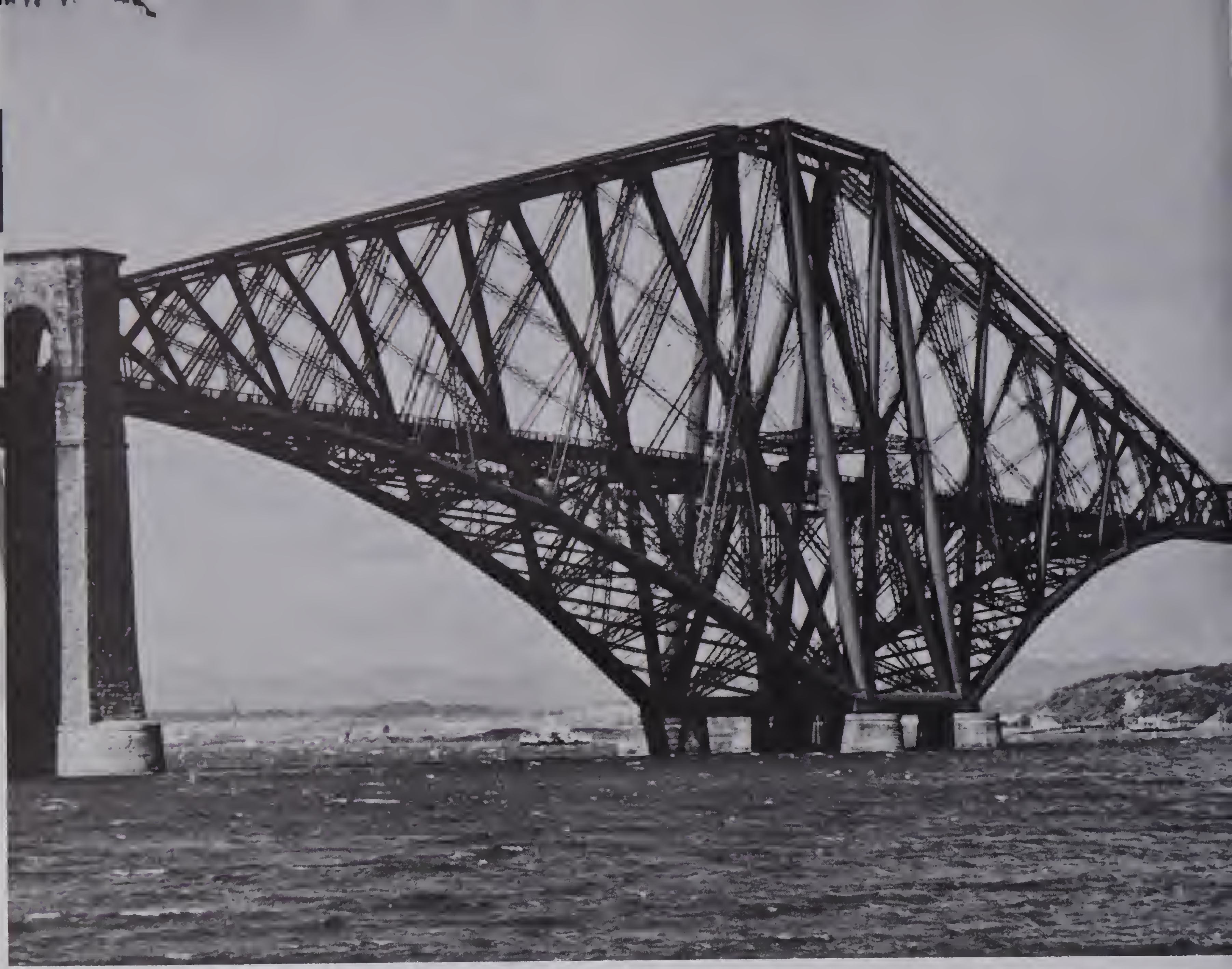
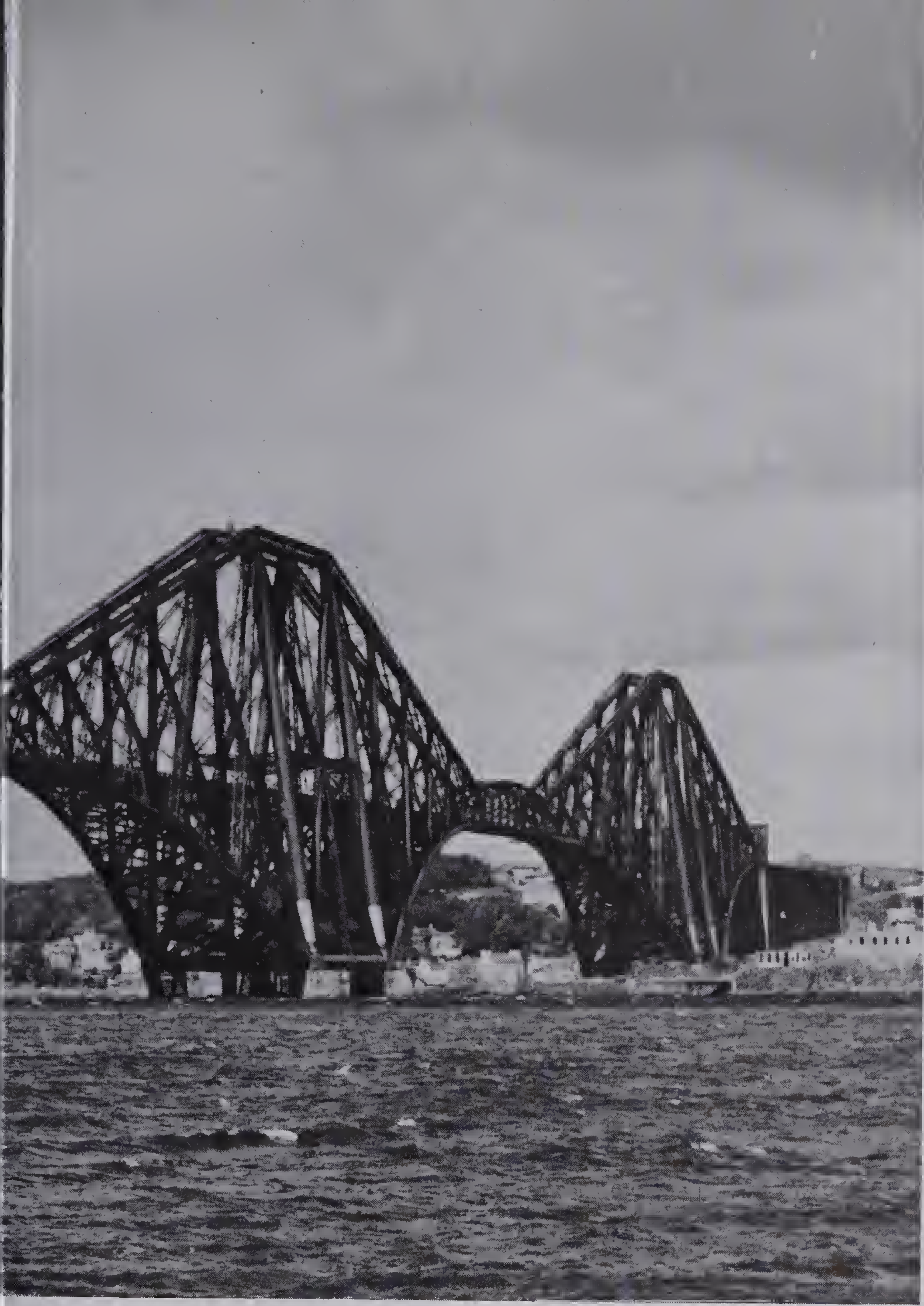


1

Picture **1** shows the Forth Bridge, designed in 1881. Until that time steel had not been successfully used for building large bridges, but the engineer who designed the Forth Bridge showed that it could be used to great advantage. His method of constructing a bridge is as natural to steel as the shape of the plastic cup on page 25 is natural to plastics. If you compare the structure of the bridge with the structure of a bone, **2**, you will see how close to nature's own methods the designer has come.
Many people found it difficult to accept the unfamiliar appearance of a structure like the Forth Bridge.
Picture **3** shows Tower Bridge in the process of being built. You will notice that the steel girders are being carefully covered up with a stone shell. Do you think this is a good use of materials?

1a

1a. *A detail of the Forth Bridge*



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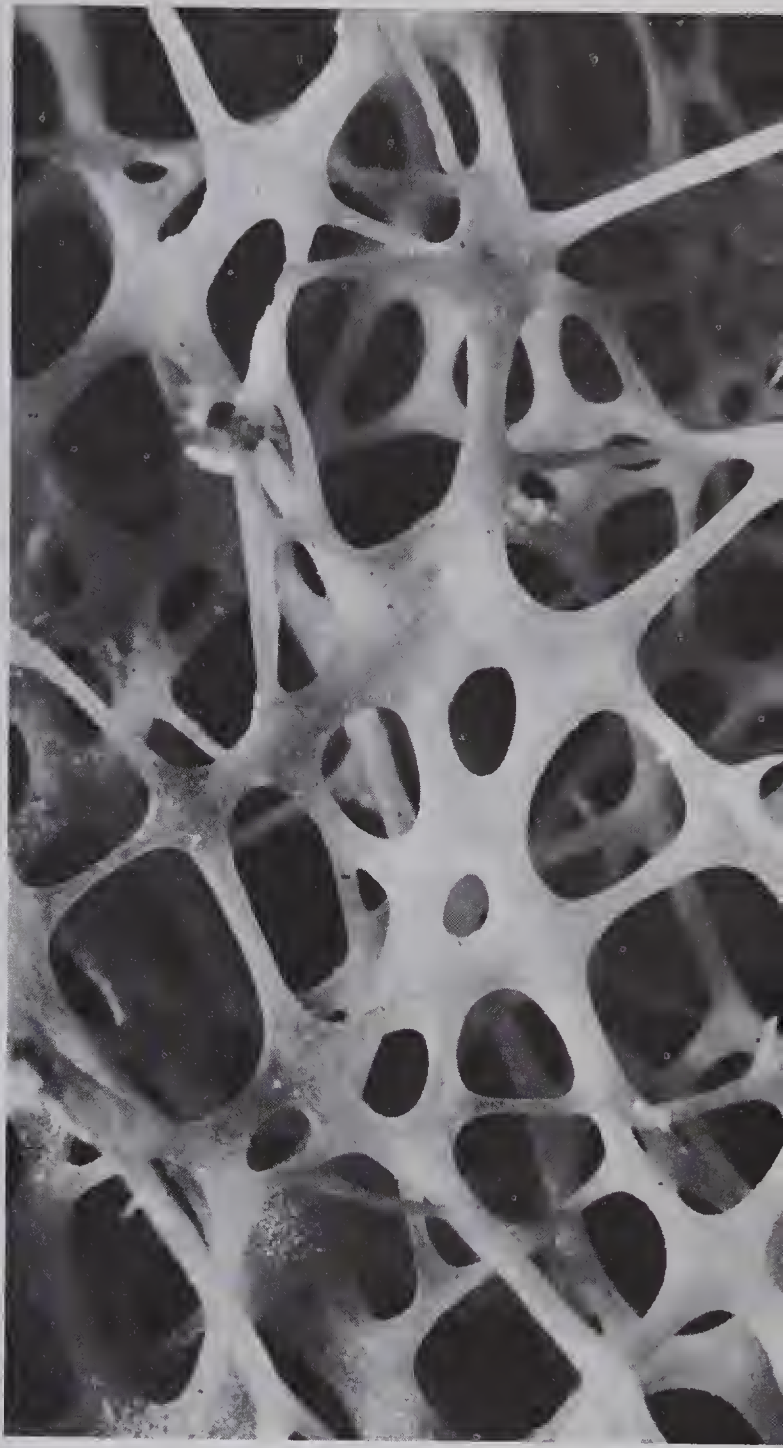

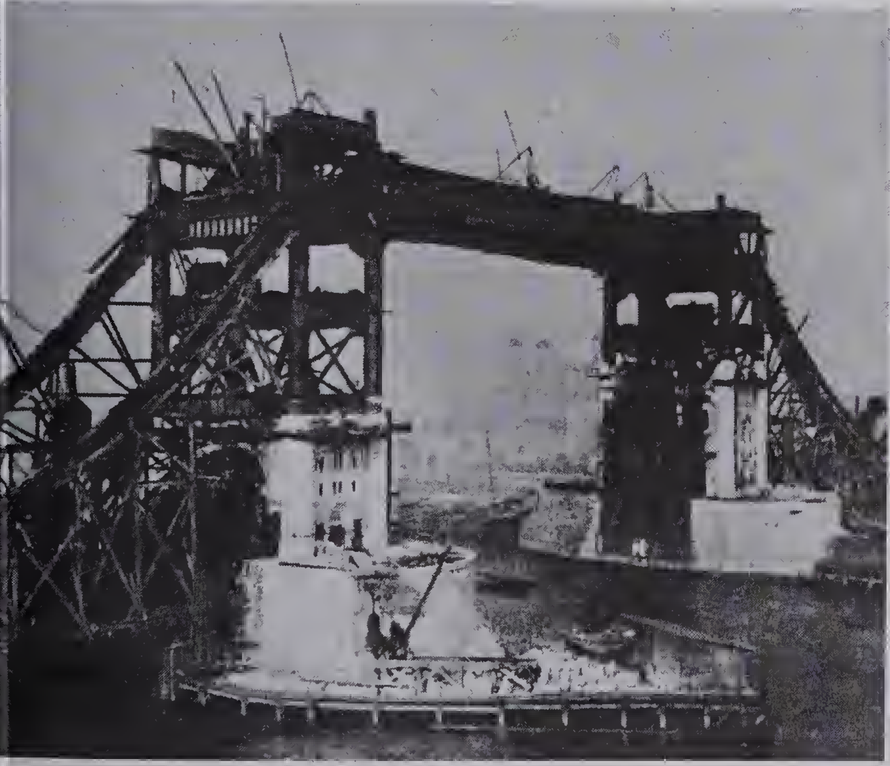

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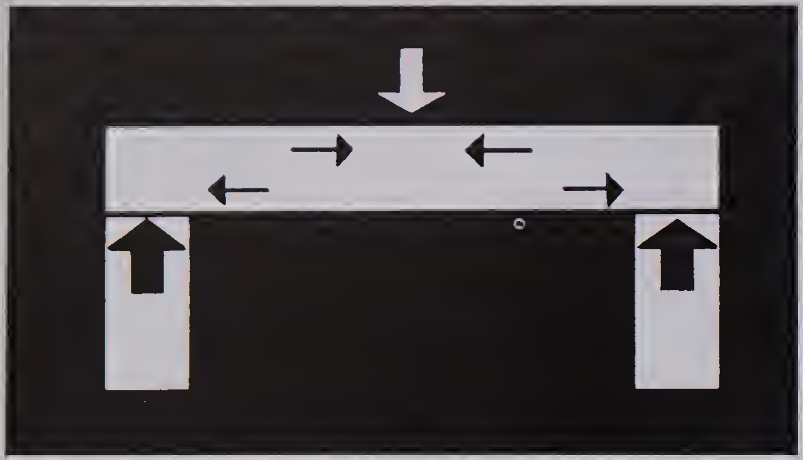

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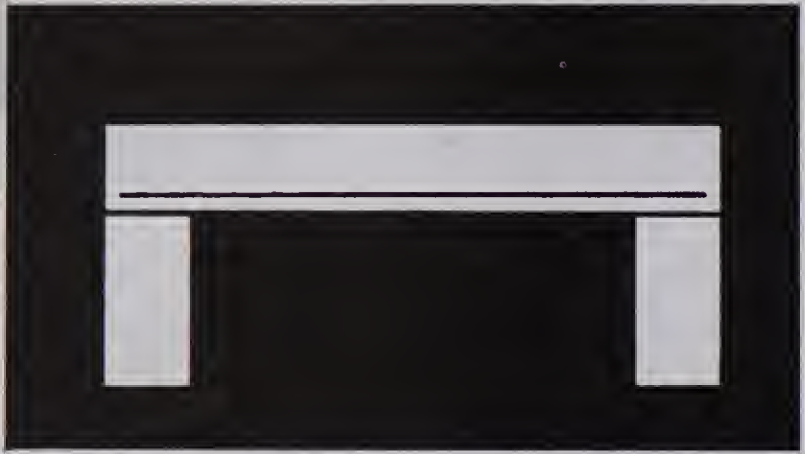

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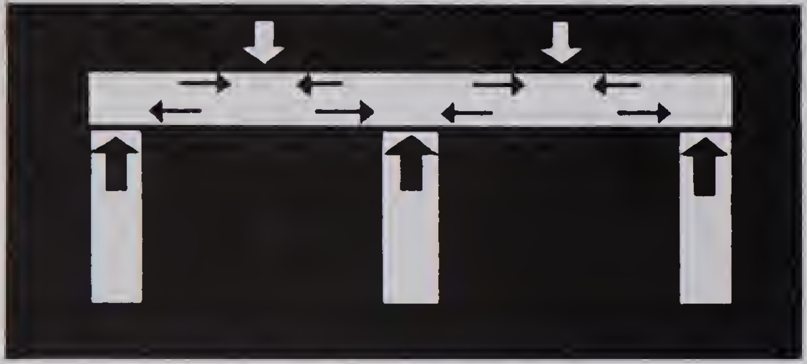

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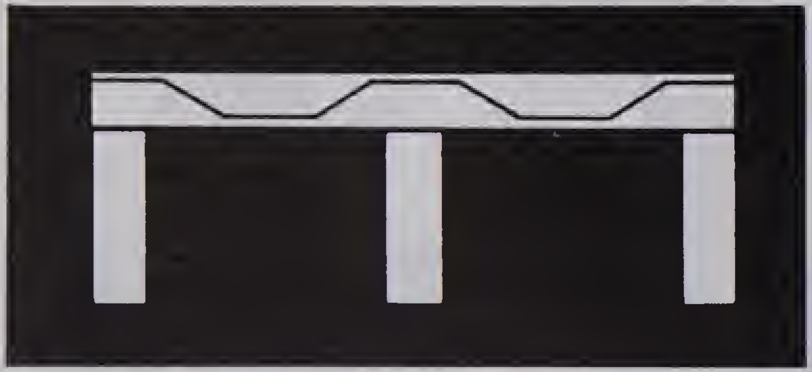
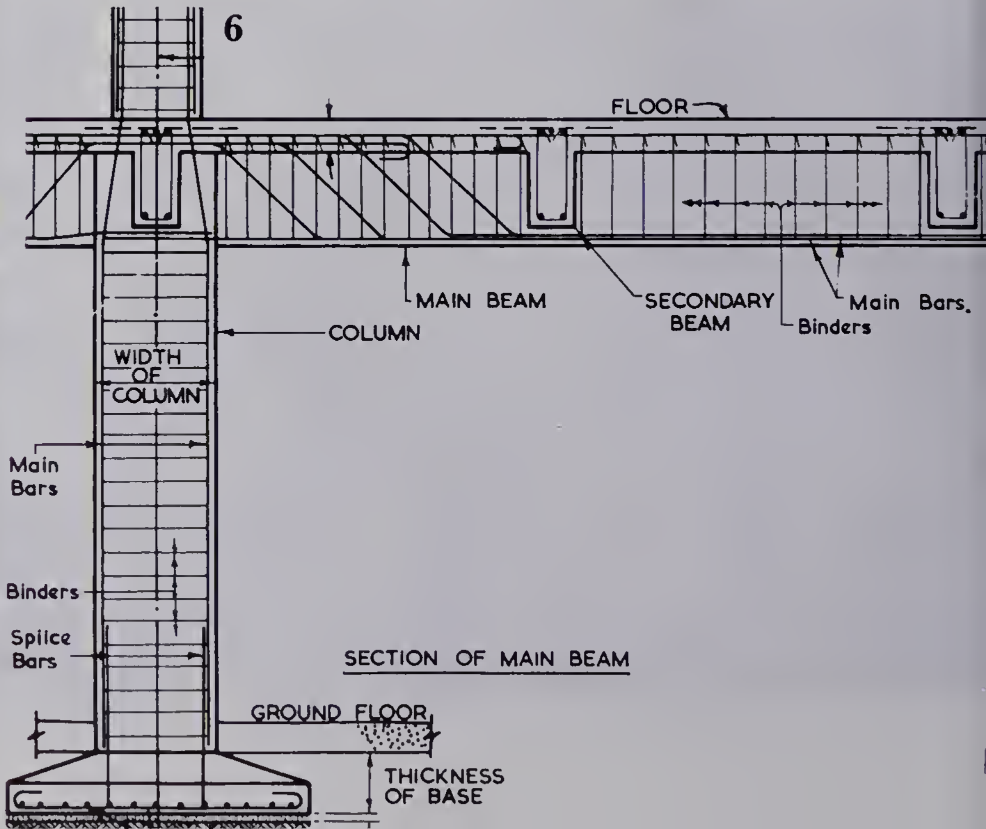


5

Reinforced concrete is another new material and to understand its shapes we must once again try to learn something about its basic principles.

If you examine a broken twig, or any piece of wood which has snapped, **1**, you will see that the break occurs on only one side, where the wood looks as though it had been torn apart, while the other side is wrinkled, as though it had been pushed together. A beam stretching between two pillars, **2**, is subjected to the same forces as the broken wood: tension on the lower side, compression on the upper. Concrete is more capable of resisting compression than tension. If a steel rod is inserted into a concrete beam where tension is likely to occur, the beam will be greatly strengthened, **3**. It can be made much thinner, which means that its length can be greatly increased without making it too heavy. The insertion of steel rods to increase the tension resistance is the basic principle of reinforced concrete. There are in practice many factors to be taken into account. For example, where a beam passes over supporting pillars, **4**, the stresses are reversed – compression on the underside, tension on the upper – and the steel rods must follow these stresses, **5**. One must consider such things as the stresses produced by secondary beams and the need to strengthen the construction by binders between the rods, **6**. Even fairly simple constructions in reinforced concrete may necessitate a complicated set of reinforcing rods, the effect of which must be calculated exactly, **10**.



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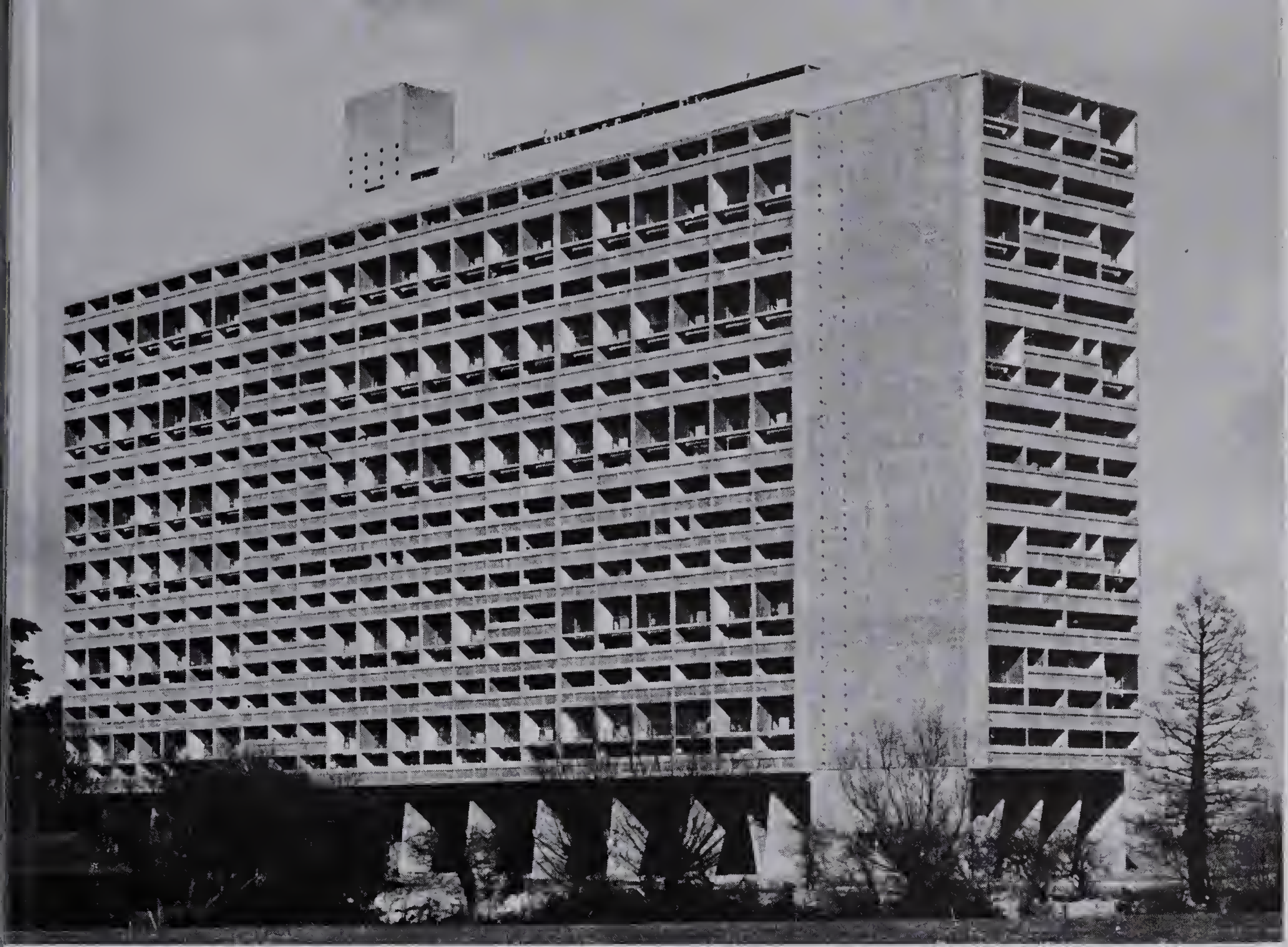
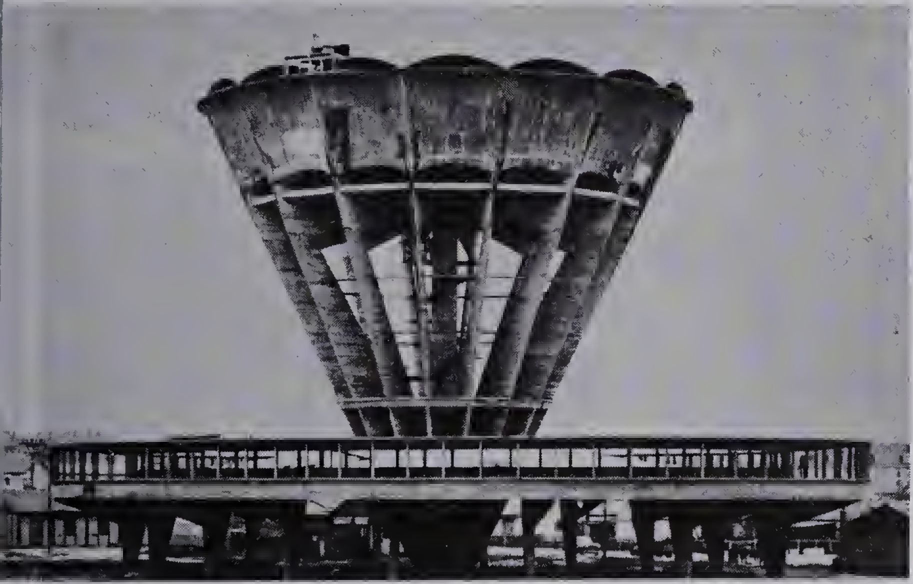
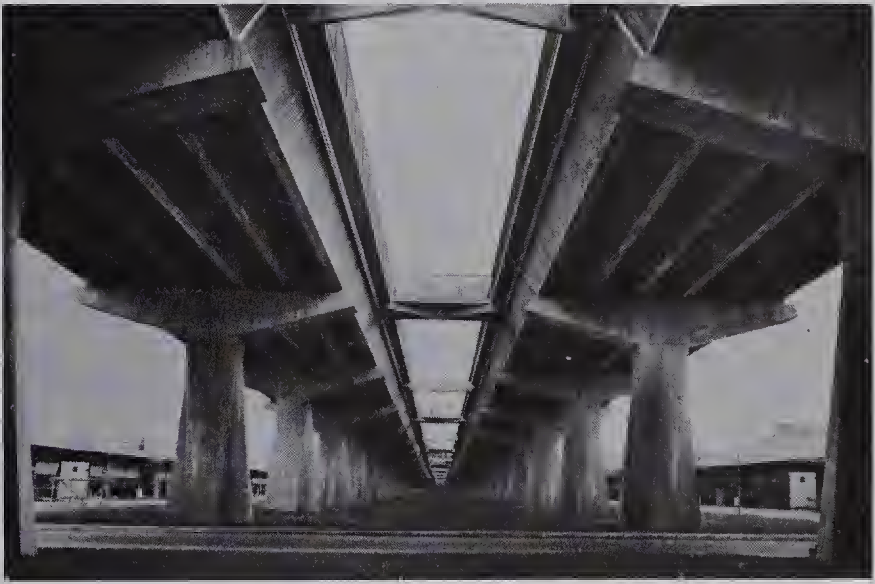


7. Block of flats in Nantes by Le Corbusier
8. Combined water-tower and covered market in a small French town
9. Road bridge in Italy
All these are reinforced concrete structures. They are typical of the shapes to which this material lends itself

8 9





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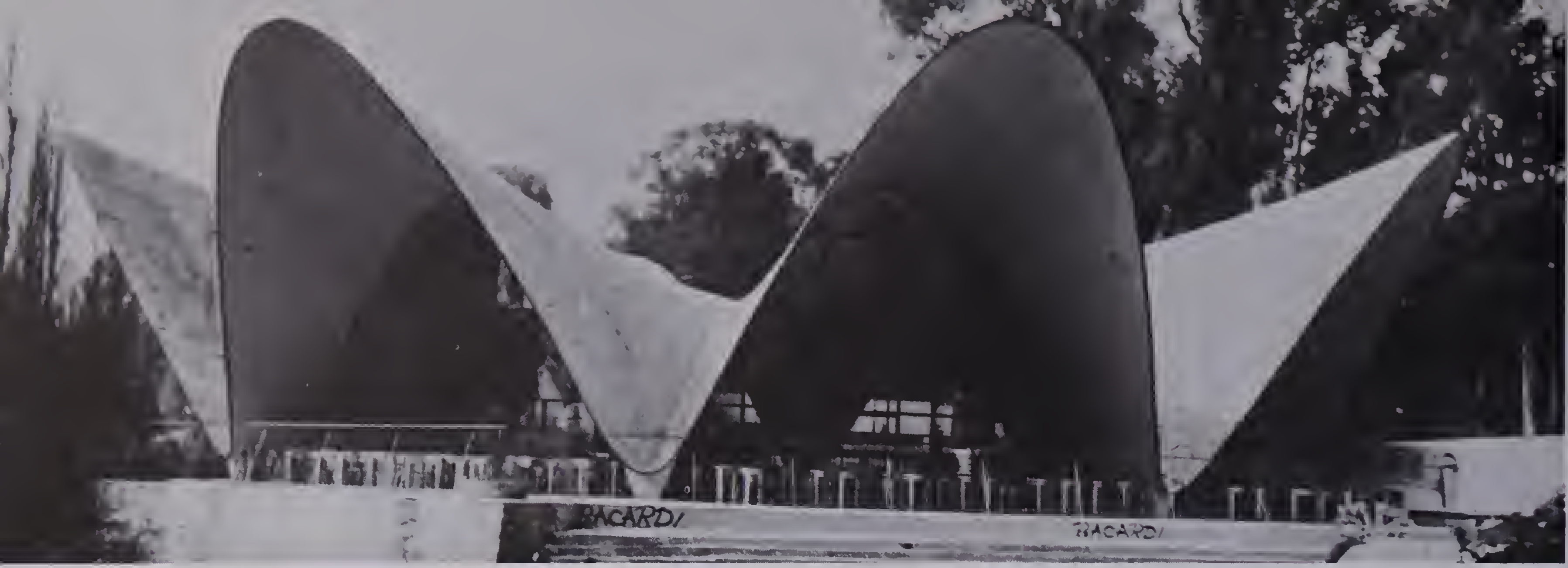

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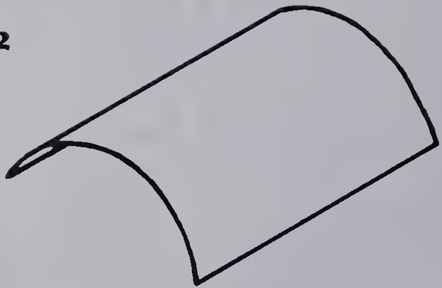
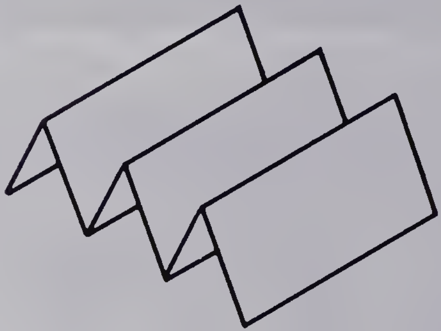
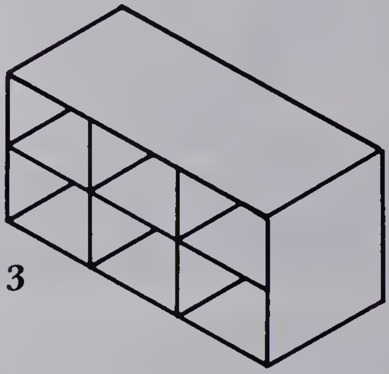
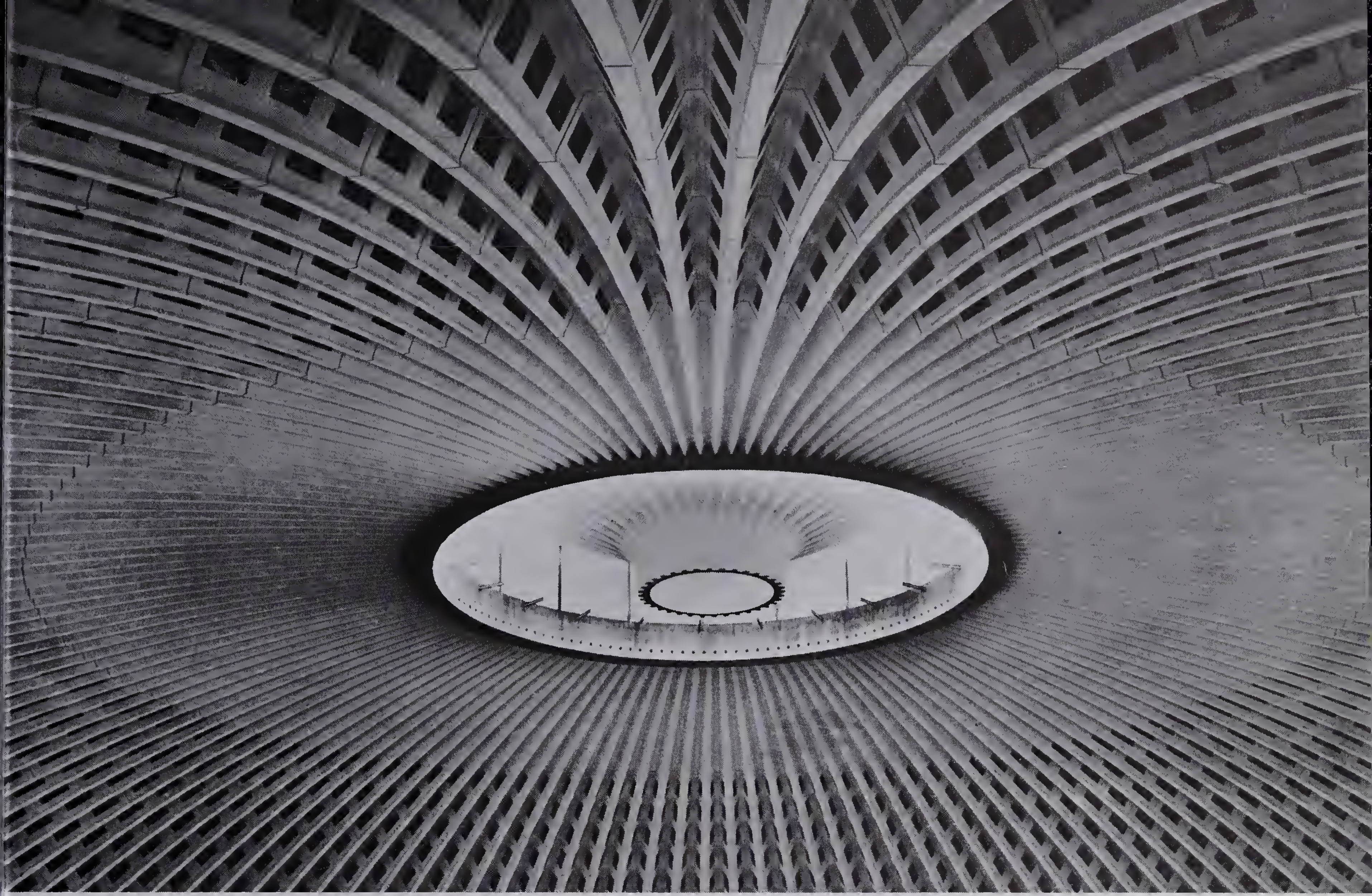






3

Reinforced concrete can be made into thin slabs and in order to obtain even more strength architects have learnt to shape these "skins" in various ways. Just as a curved or rolled-up piece of paper is stronger than a flat piece, so is a curved piece of reinforced concrete stronger than a flat piece. Basic shapes such as **3** *are ideal for reinforced concrete structures. The unusual appearance of some reinforced concrete structures is due to the fact that this material gives of its best in shapes like* **1**, *a restaurant in Mexico designed by Felix Candela, and* **2**, *the UNESCO building in Paris.*



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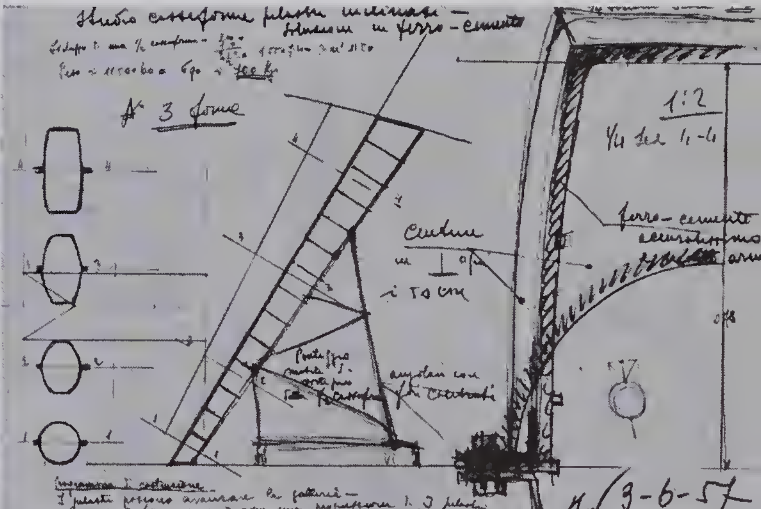
5 **6**



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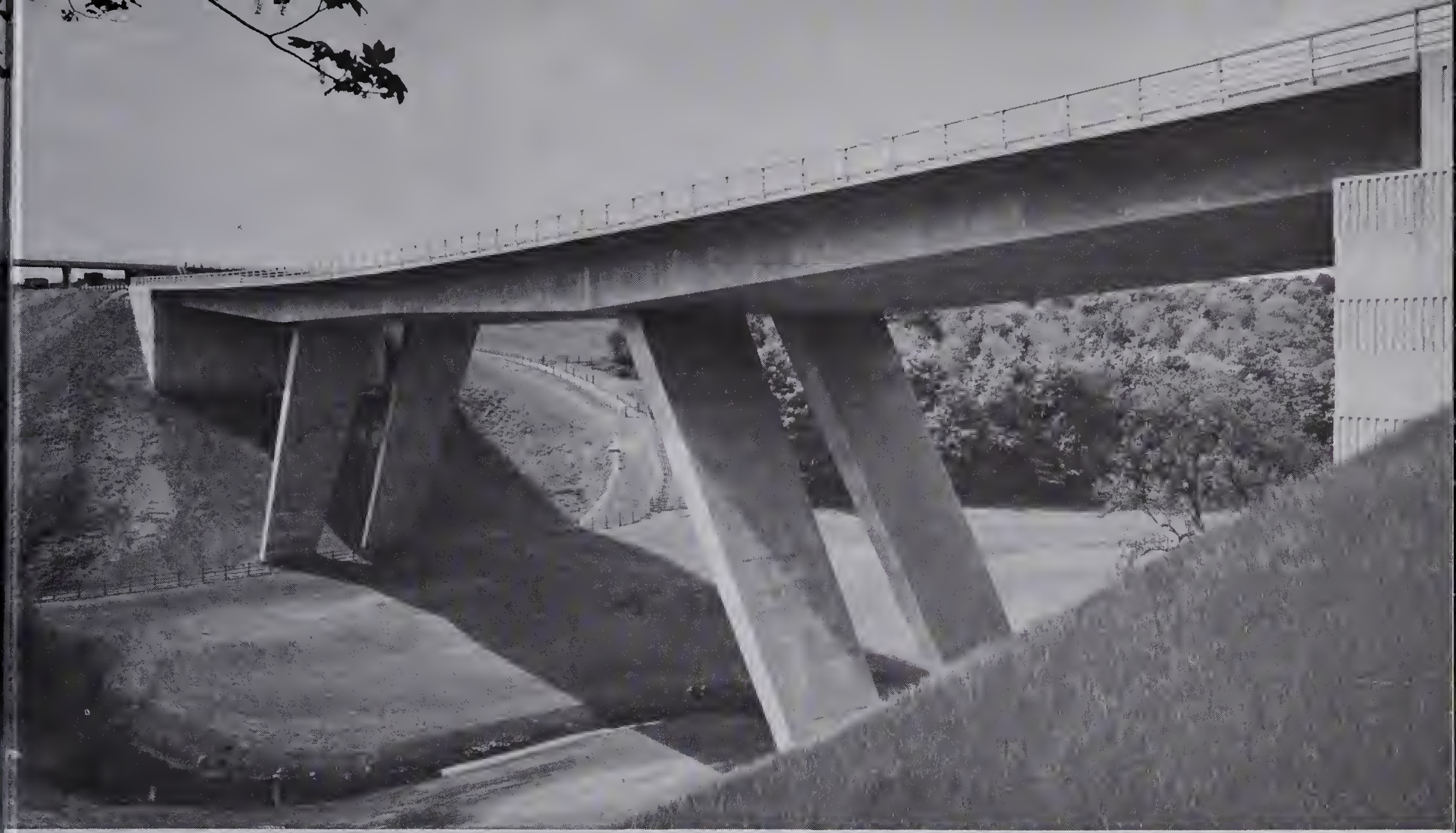
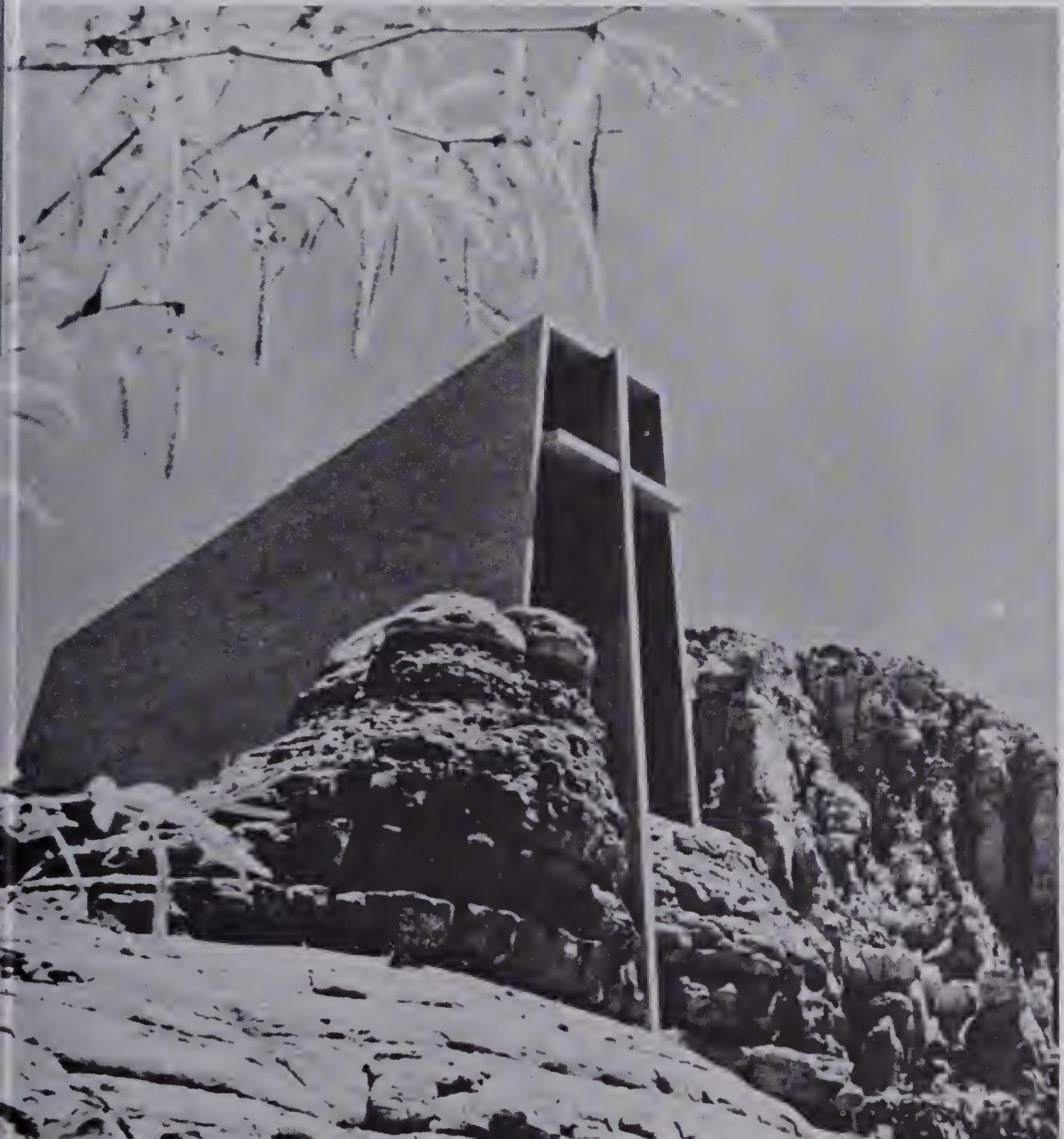
*4 to **6**. The huge Sports Palace in Rome, by Nervi, is a mathematical structure. All the shapes and patterns you see are practical shapes and not just ornaments. The architect's drawing, **6**, shows that the structure and the sections of each member were thought out as a mathematical problem.*

1

2

3





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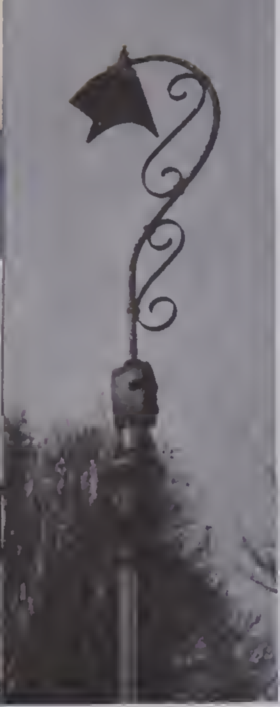
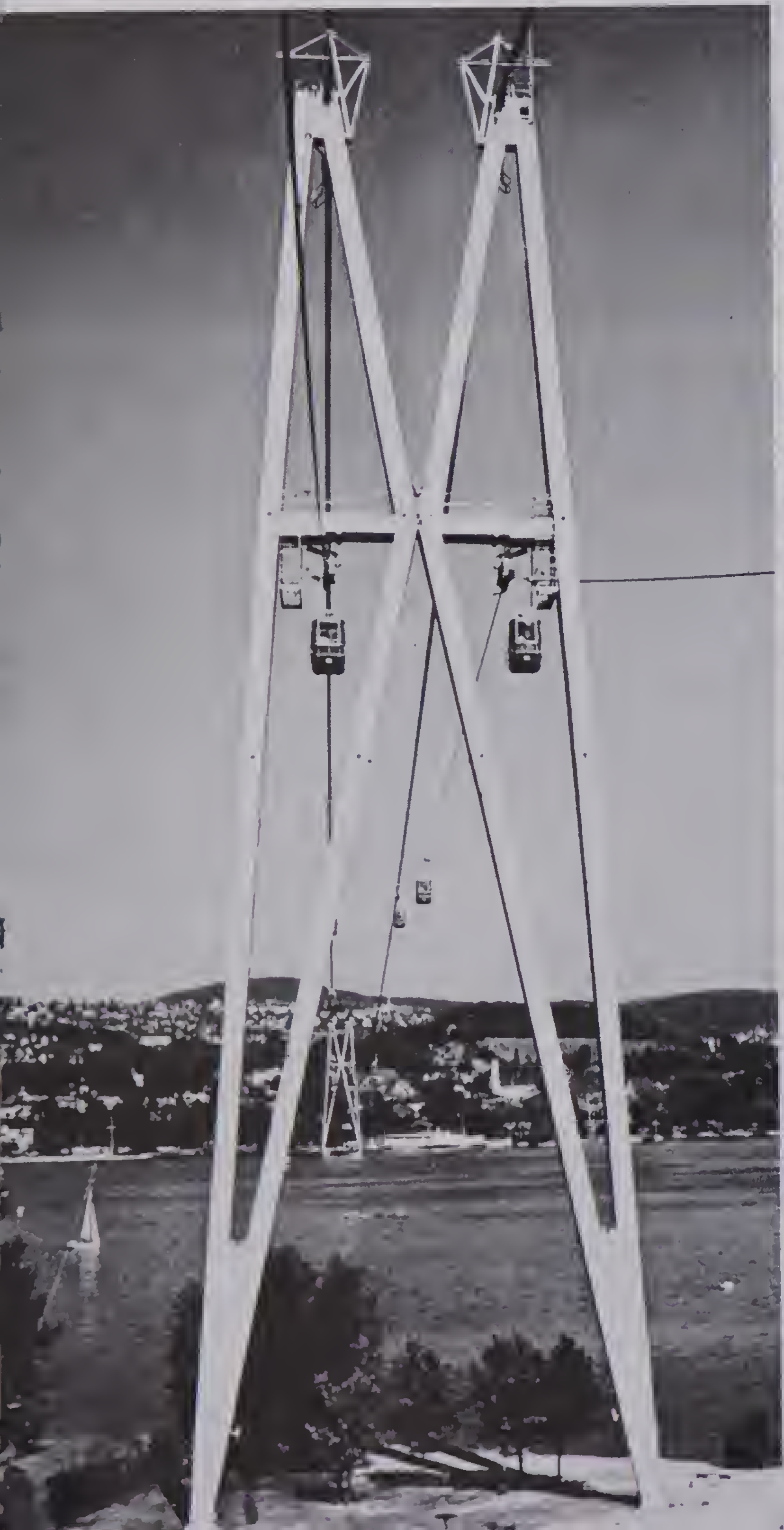
Reinforced concrete has many advantages over other building materials and it lends itself to new and wonderful shapes. Windows are replaced by walls of glass which by night and by day reveal the inner structure of the building, **1**, **3**. *Because reinforced concrete shapes can be built with a minimum of material they have a feeling of lightness and elegance,* **2**. *In the case of large structures this helps them to fit into the pattern of the countryside without disturbing it,* **4**, **5**.



The graceful lines of the Swiss funicular, **2**, *and of the lamp post,* **3**, *are mathematical structures which give the greatest strength combined with the least amount of concrete. The thickening at the base of the lamp post houses the control box, yet the whole thing is conceived as one shape. Some of the older lamp posts have no such coherence and are composed of many different parts, often completely unrelated,* **1**.

1

2



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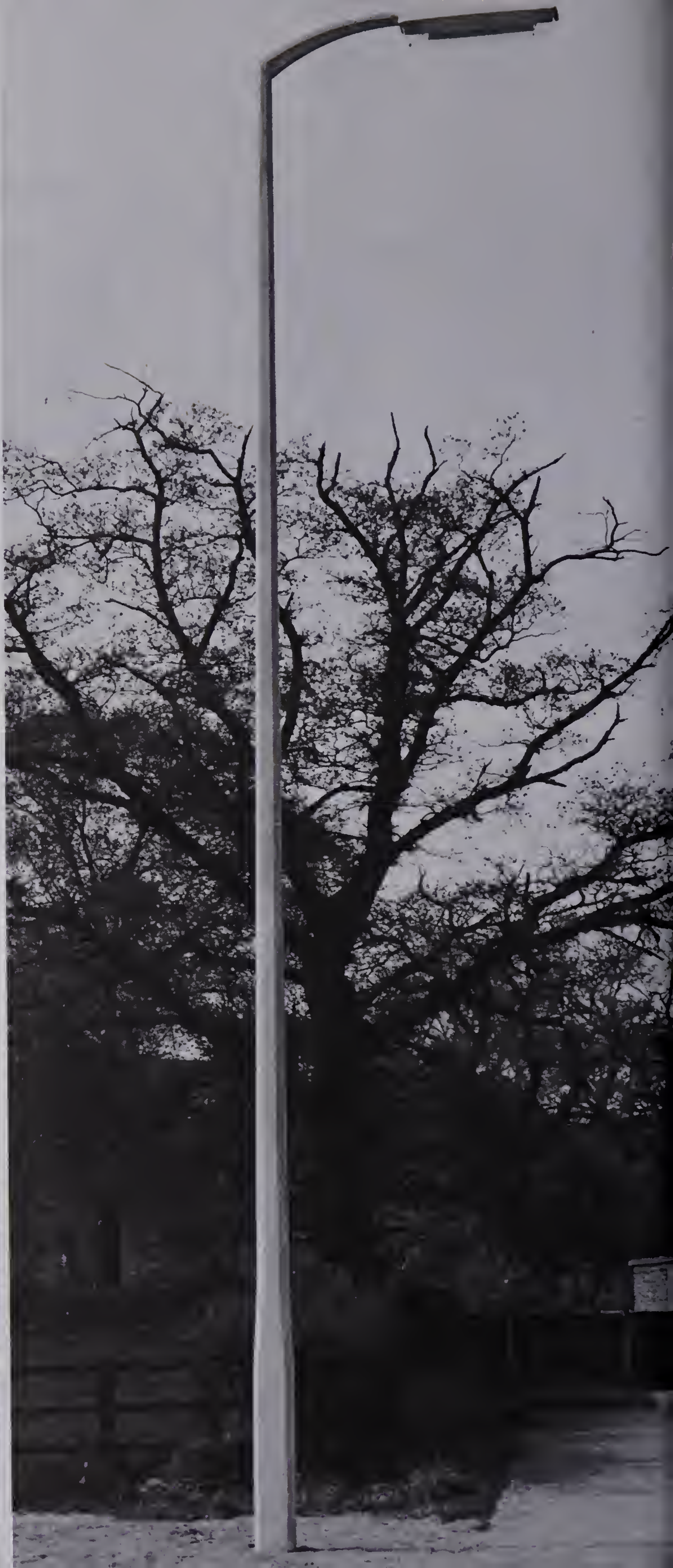

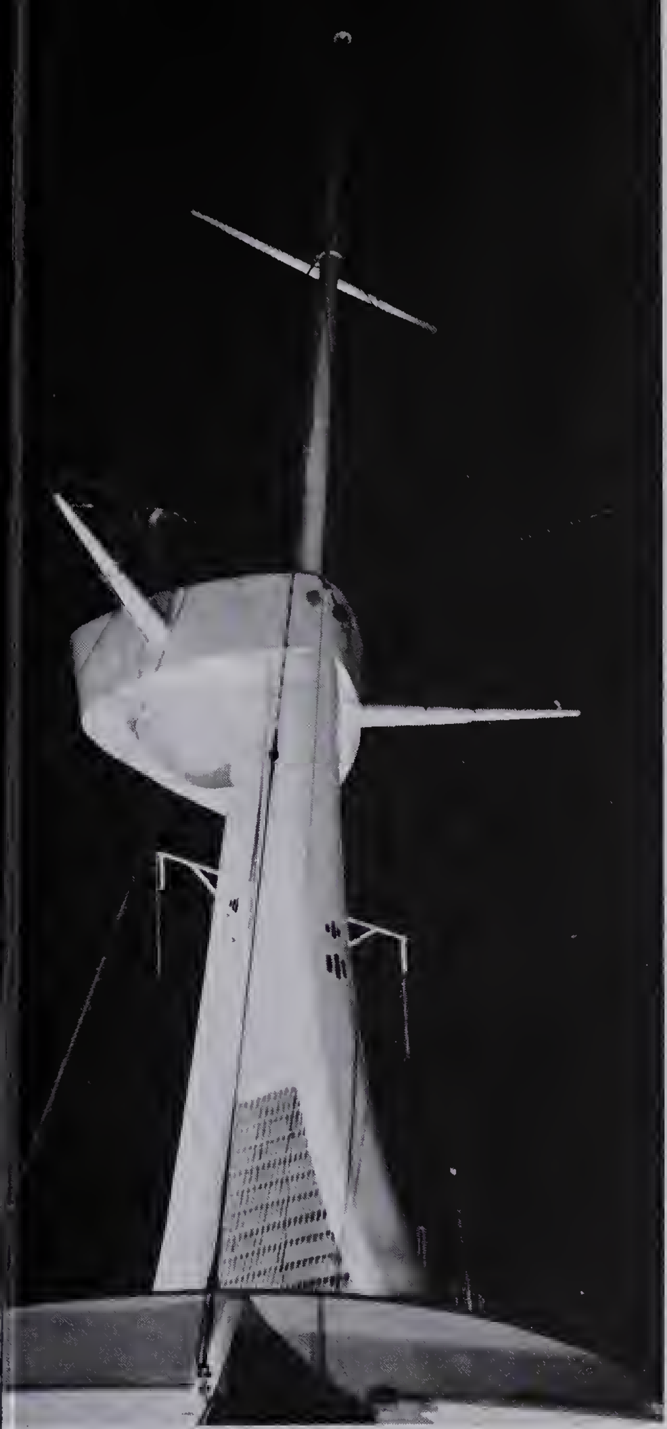

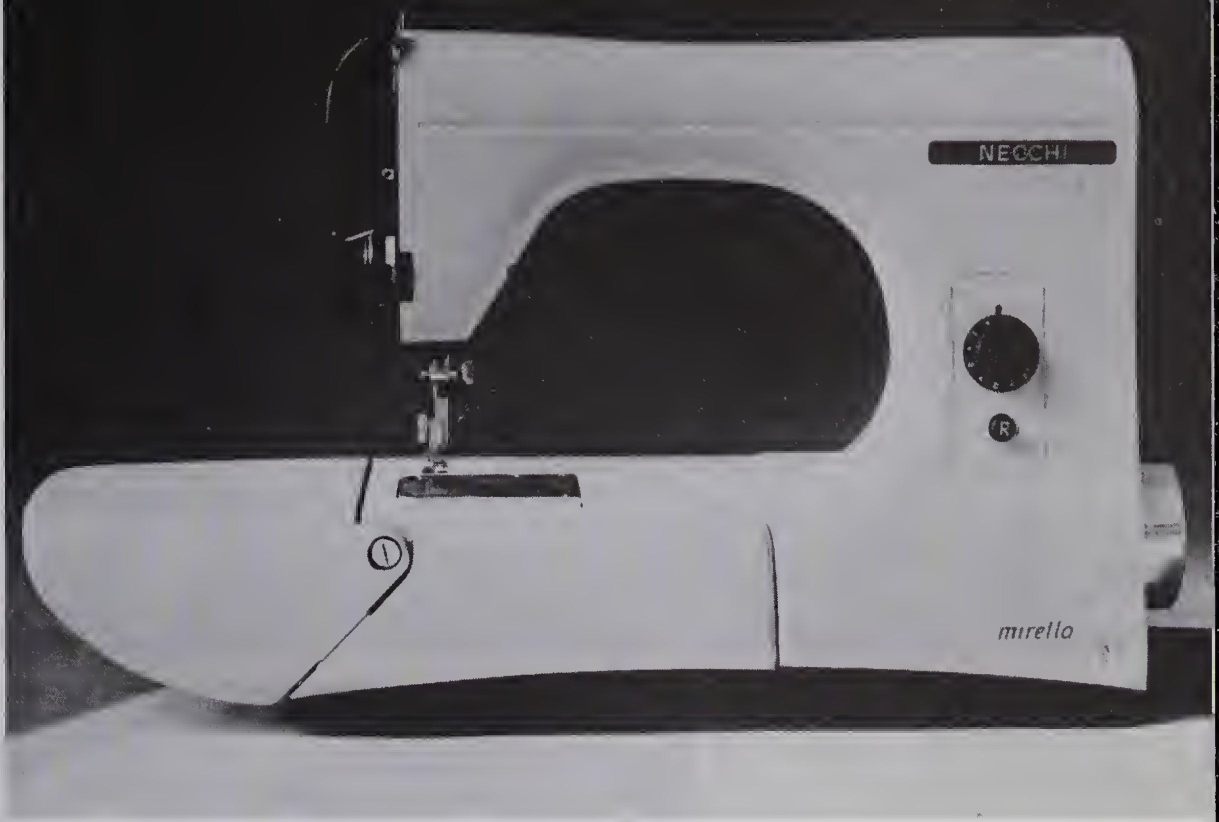

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Another comparatively modern material, aluminium, has affected the shapes of many objects. The ship's mast, **4**, *is different from the usual mast because it is built of aluminium. The top part of the sewing machine,* **5**, *is an aluminium alloy casting which has made it possible to simplify the overall shape. The structure,* **6**, *made of aluminium tubes, is designed to find out how aluminium can be used in building and engineering.*

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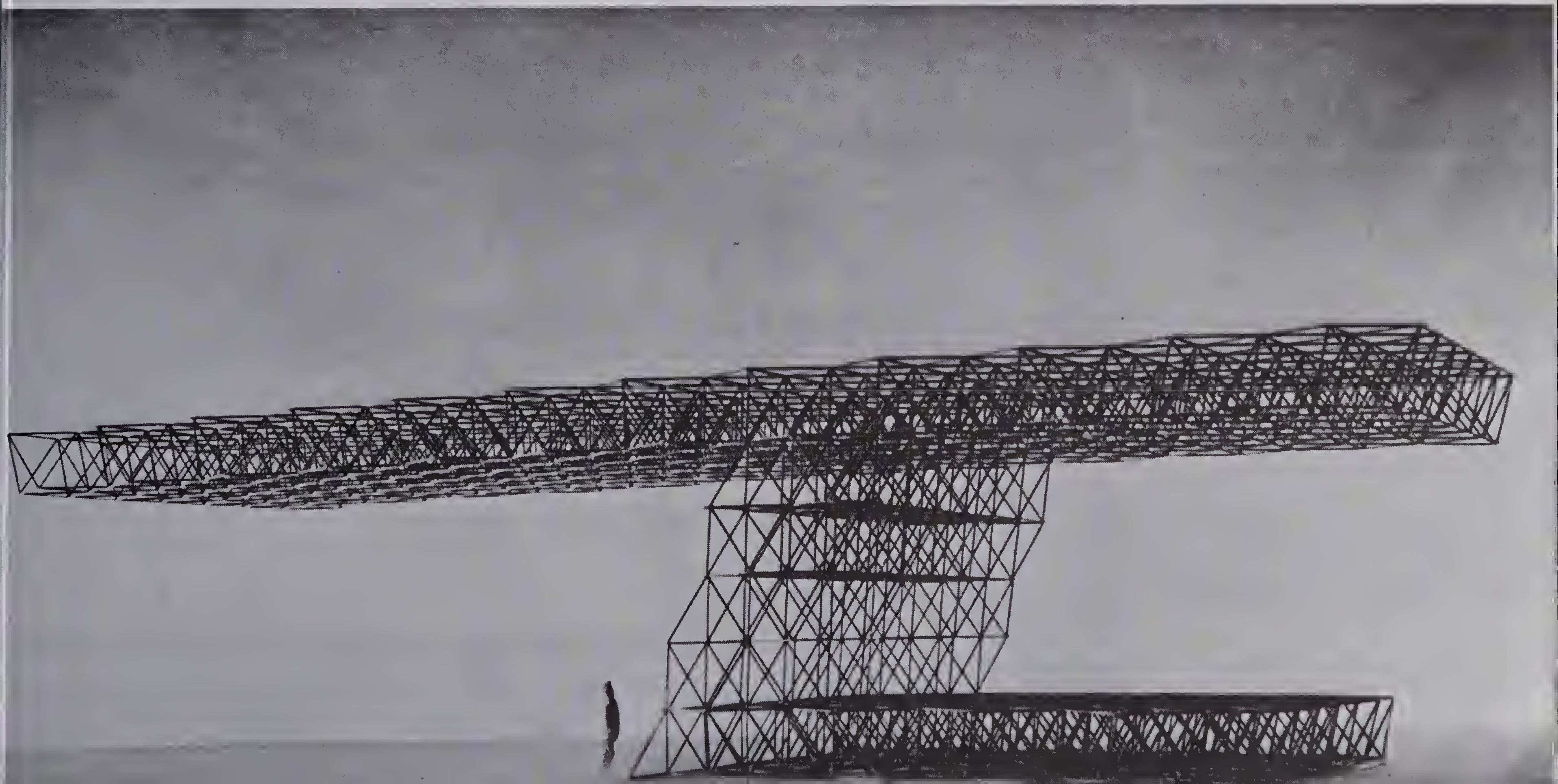

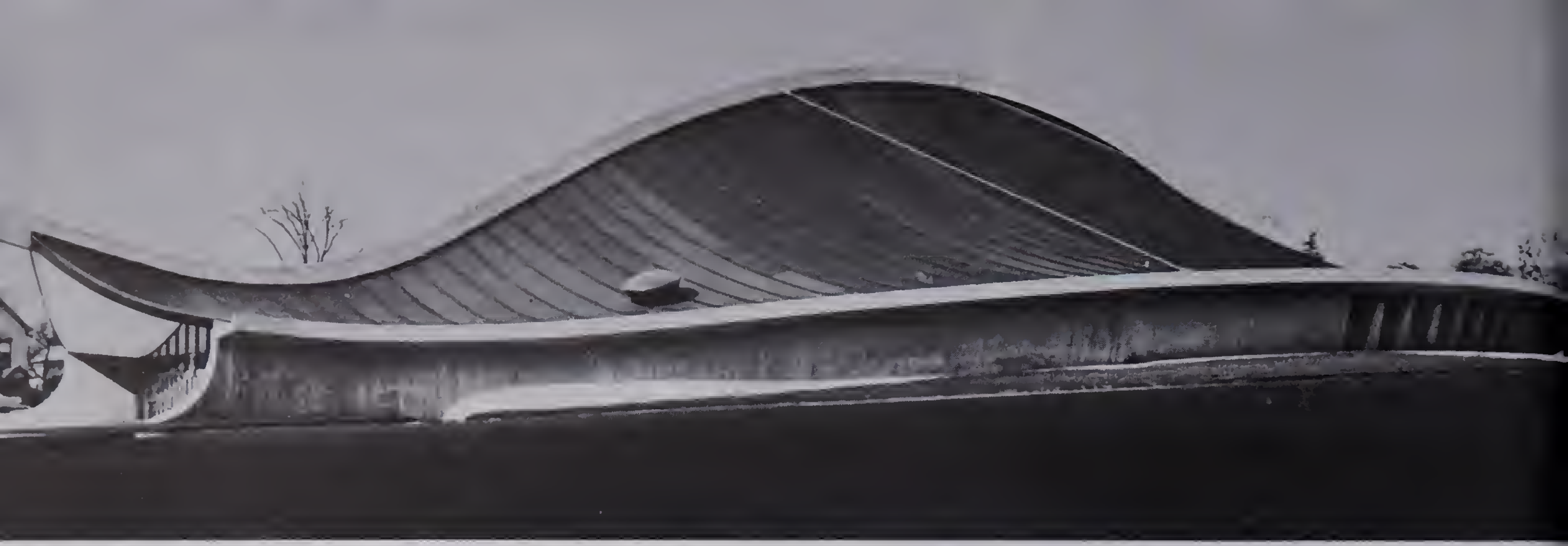

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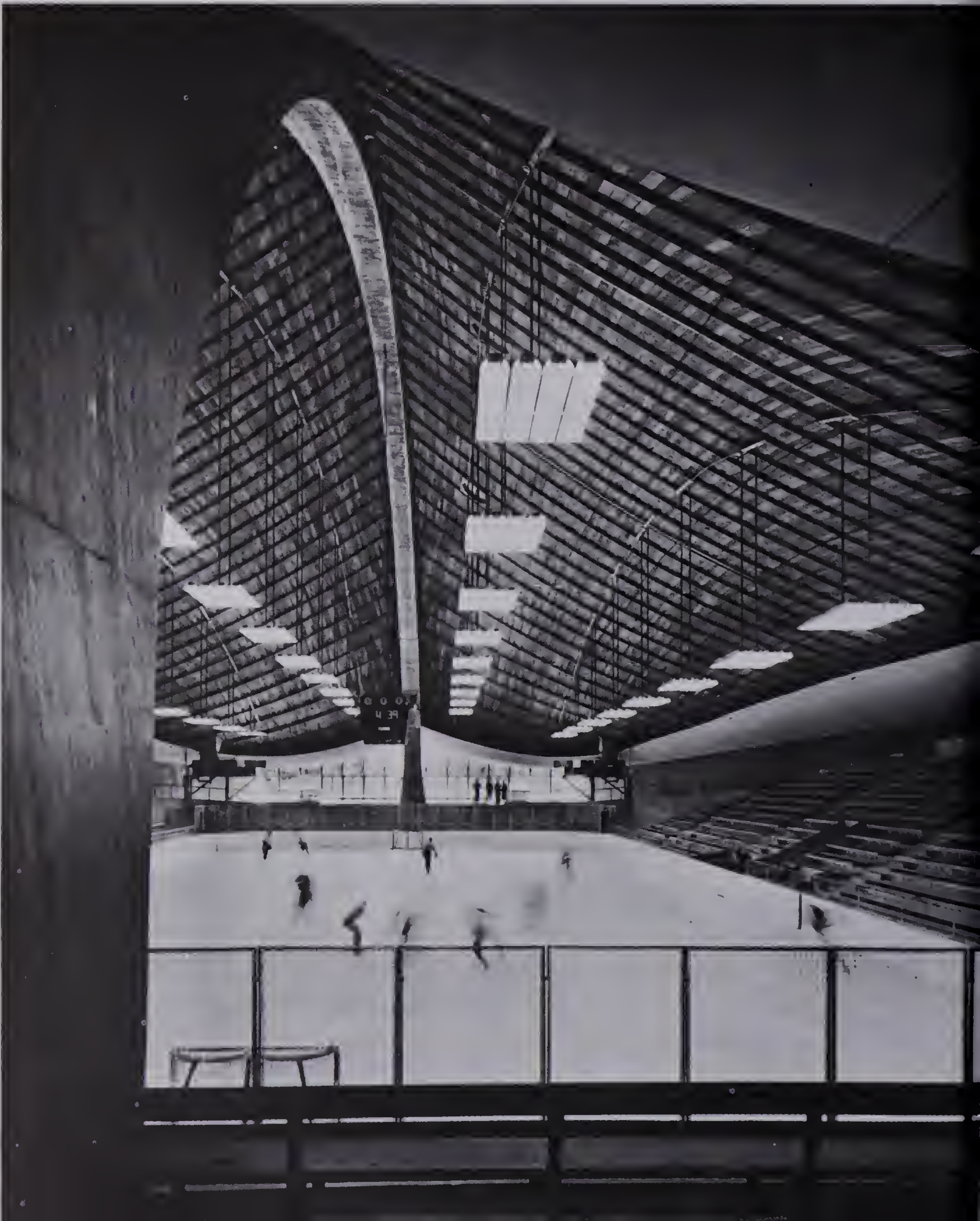
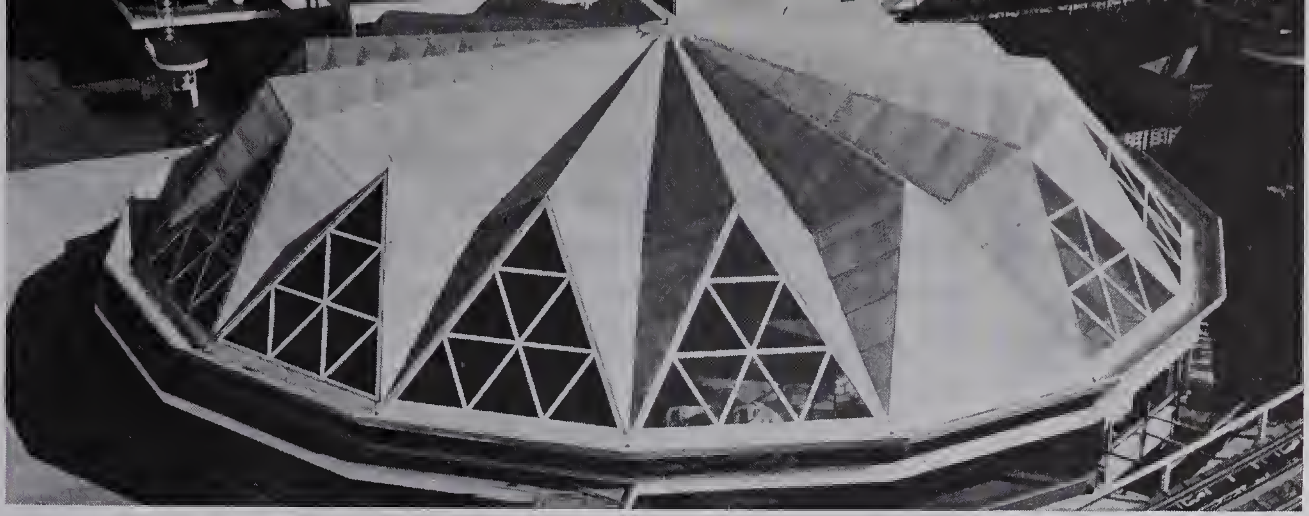


In this skating rink by Saarinen, **2**, *at Yale University a number of materials were used together. The centre arch is of reinforced concrete, steadied by six outside steel cables which you can see in picture* **1**. *The wooden roof rests on another set of cables and is covered with plastic on the outside. This ingenious construction by a great architect achieves an unusually wide span without the need for pillars. The graceful structural curve and the whole construction have been left bare so that we can almost see the architect's mind at work.*



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TO SUM UP

In an ideal shape there is a perfect relationship between the shape on one hand and the material and the method of manufacture on the other. In order to understand any man-made shape, therefore, we must first try to understand something about how it was made. We must expect new and unfamiliar shapes to result from the use of new materials. We must also expect new shapes to result from new processes of manufacture, even where these are applied to traditional materials. If mankind is to gain the maximum benefit from the introduction of new materials and new processes, new shapes must be found to match them.

EXERCISES

1. Find examples of the same object made in different materials. Explain which example of each you like best and whether it uses its material to the best advantage.
2. Picture **3** shows the Derby Racer at Blackpool. The roof structure is made of nailed and glued timber boards. It has no internal support. Do you think the designer has put the timber boards to good use? Should he have attempted to build a structure like the one in picture **1** on page 36?
3. Examine the plastic wheelbarrow in picture **4**. Explain whether the designer has used the material and the process of manufacture to the best advantage. Do you think it will be easy to use?
4. Find a number of objects (including buildings) in which modern materials are used. Give reasons why you think they are used in this particular way.
5. Make a list of all the modern materials you can think of and explain the advantages and disadvantages of each.

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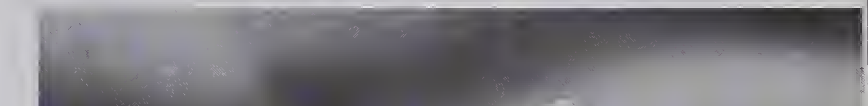

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Shapes with a purpose

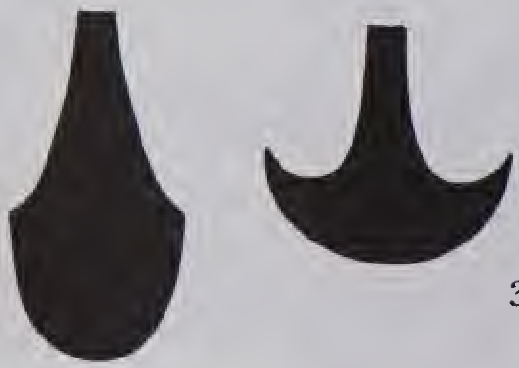
If you were completely cut off from civilisation, what would you do to make life tolerable? You might set about making such things as a hammer, a knife, a punch for making holes, a chisel, and so on. Perhaps the shapes of some of the natural objects around you would suggest ways in which they could be used.

A twig, **1**, might be used for a hammer. A broken flint, **2**, would serve as a knife. You would probably find it quite easy to make your selection of useful tools because you would already be familiar with the traditional shape of such things as hammers and knives.

But the first man to use a natural object as a tool had no preconceived idea about the shape. Faced by a heap of broken flints he had to try first one, then another, then a third, until he found the one which was best for the job. He had a choice of many shapes, of which one proved to be the most efficient. It was that shape which he imitated when he made his own first tool.

This process of trial and error was repeated when man discovered bronze and later iron. As we shall see, it is a natural process, which occurs very often. Let us consider once again how bronze tools were developed. If you look at pages 10 and 12, you will see from the pictures of celts and spear heads how during the Bronze Age each shape developed from the previous one.

But in reality the process was a little more complicated than these pictures suggest. The second celt for instance (page 10, **2**) which marks the first step in the direction of true bronze tools, is of course a development of the tool which imitated a stone tool. Was this development the only possible one? Is it not likely that in working the bronze other shapes might have come about? The shapes in picture **3** on this page might also have been made, and there are probably a great many other possibilities. The reason which made man select one particular shape is the same as his reason for selecting the most suitable flint from the pile of natural flints: it served his purpose better than every other shape he had tried, and it continued to serve his purpose until in its turn its place was taken by another shape which was found to be still more efficient.



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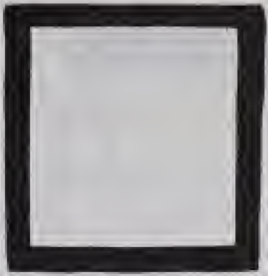
Perhaps the following example will make this a little clearer. Imagine that you wish to make a wooden frame strong enough to support some weight. Imagine, too, that you have never done any woodwork, or seen any wooden constructions. Your first effort, made of four pieces of wood, may look like **4**. As you will soon find out, however, a frame like this collapses when a weight presses down on it. You nail two more pieces of wood to your frame, **5**, but once again it collapses. As you can see there are many possible ways of reinforcing your frame, and you continue to experiment until in the end you find an efficient way of making the frame you want, **7**. This shape, among various other possibilities, will do the job best, use the least material, and be easiest to make. It is also the most pleasant to look at.

The shapes of all living things were arrived at by a similar process. For example, pictures **8** to **11** show how the shape of the horse's foot has developed. The shapes of the different bones which make up the foot changed as the horse's habits and environment changed and the foot was used in different ways.



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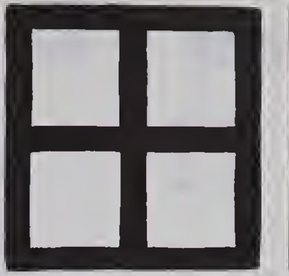

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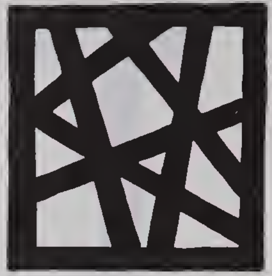

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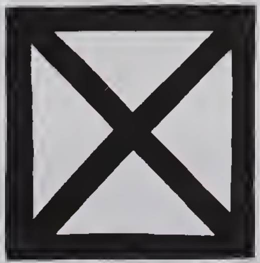

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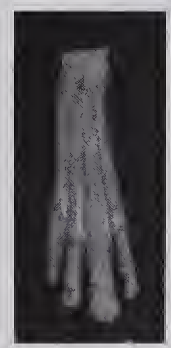
Over a long period, climatic conditions caused the horse's habitat to change from soft ground, **12**, *to hard,* **13**. *This produced gradual changes in the shape of the horse's foot,* **8**, **9**, **10**, **11**. *Other parts of the horse's body also changed, and with it the overall shape. At each stage only the most efficient shape survived. Just as the early tool-maker looked for the most efficient shape and selected it, nature also selects the most efficient shapes. This process is known as Natural Selection.*



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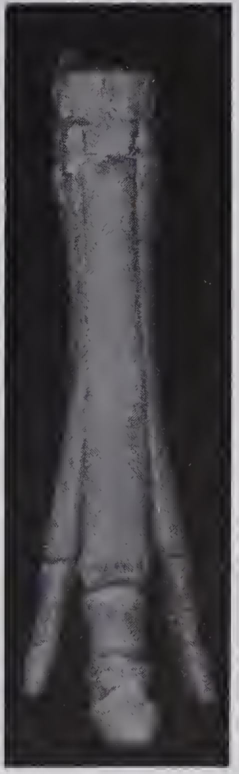

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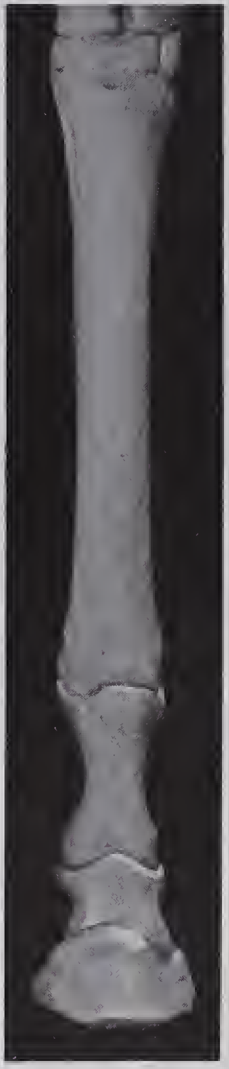

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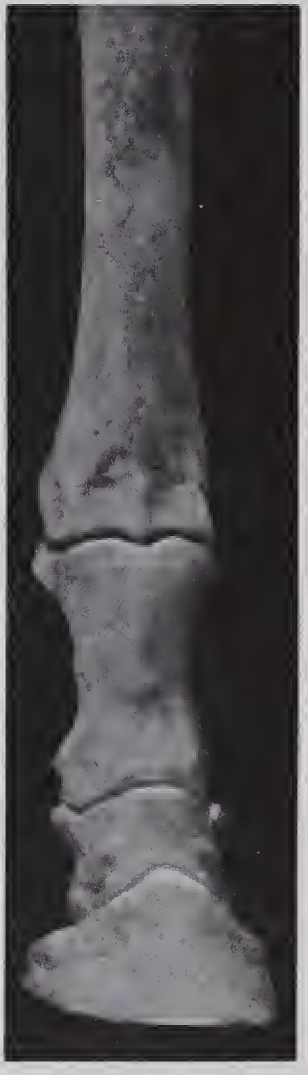

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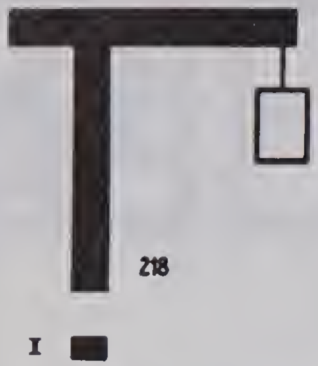

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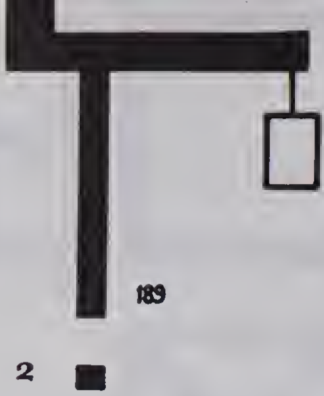

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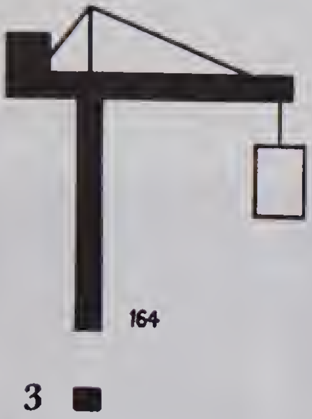

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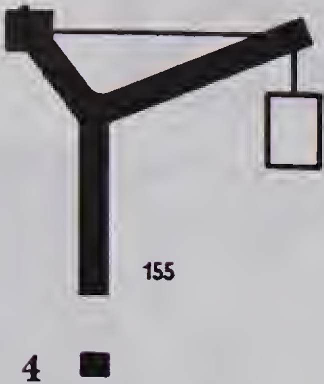

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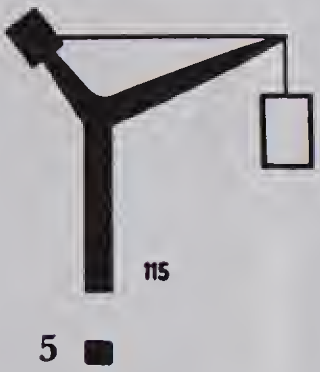

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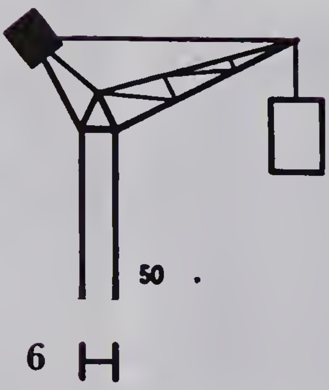

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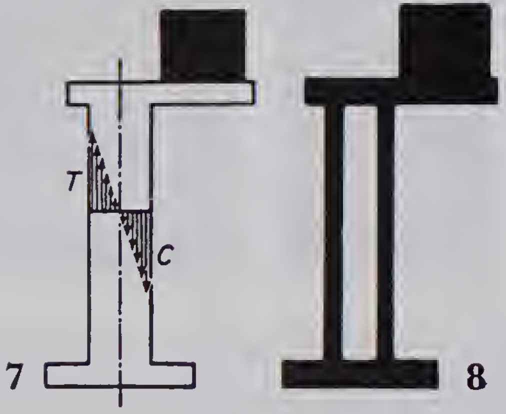


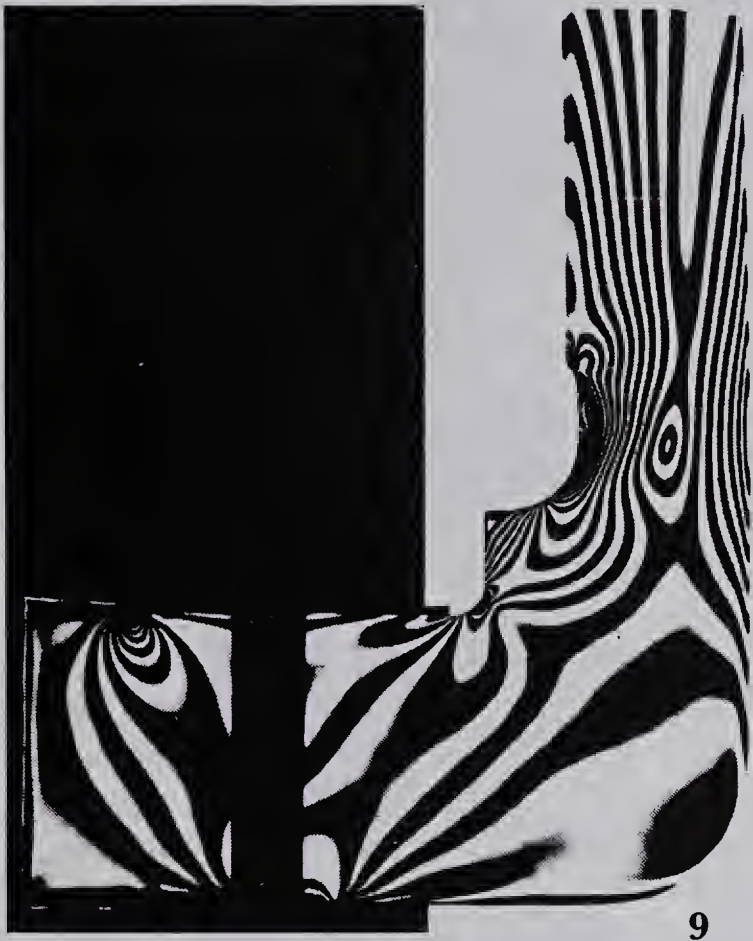
A load which presses down on one side only causes both tension and compression in the upright. Compare this to the beam on page 34. As the diagram, **7**, *shows, by far the greatest tension (T) and compression (C) occur near the edge, so that if these parts are made strong enough the forces acting inside the upright can be ignored. The hollow shape,* **8**, *will do the same job as the solid shape,* **7**. *Since it uses less material we can say it is more efficient.*

The changes whereby nature produces efficient shapes are so gradual that they become apparent only with the passing of hundreds of thousands of years. Man-made shapes, however, evolve much more quickly. Imagine that you have constructed a crane strong enough to lift a certain maximum load. The weight of your crane is, say, 218 kilogrammes, **1**. If you try to reduce the weight of the crane by reducing the amount of metal in its construction, without changing its shape in any other way, you will weaken it so that it cannot lift so heavy a load. If, however, you counterweight the load, **2**, the upright can be made thinner without any loss of efficiency. This second crane weighs only 189 kilogrammes, a considerable saving over crane **1**. Further changes in the shape of the crane continue to improve its efficiency. By introducing a brace on the horizontal beam, **3**, further weight is saved, and the crane, now weighing only 164 kilogrammes, can still lift the same load. The crane can be lighter still if we make the crossbeam in the bent form shown in picture **4**. Because the stresses decrease towards the ends of the crossbeam, these can be tapered, with further economy of material and without any loss of strength, **5**. But now a further consideration enters our calculations. When an upright is evenly loaded, the stresses occur throughout its thickness, but when the load is on one side the stresses, partly tension and partly compression, are greatest at the surface, while the middle bears hardly any stress at all, **7**. To leave out the centre portion of such an upright will therefore not weaken it. A hollow tube, or specifically shaped lengths of metal, weighing much less than the solid upright, will do the same job, **8**. If we apply this principle to the crane we can reduce its weight to 50 kilogrammes. In its final shape, **6**, the crane will perform the same task as the crane in picture **1**, but it will be lighter, use less material, and be easier to handle. In other words it is more efficient.

The shapes of many man-made things are mathematically determined in this way – the Firth of Forth bridge, for example. We can call them logical shapes because they are the outcome of reasoning.

When an object is pulled or squeezed we say it is under stress. Your wooden frame was under stress.

When you hang a weight from a crane hook it comes under the stress of the weight. This stress can be shown by a special photographic process in which the lines represent the forces which act on the object. If you wish the object to be strong you must build it in such a way that these forces will be resisted.



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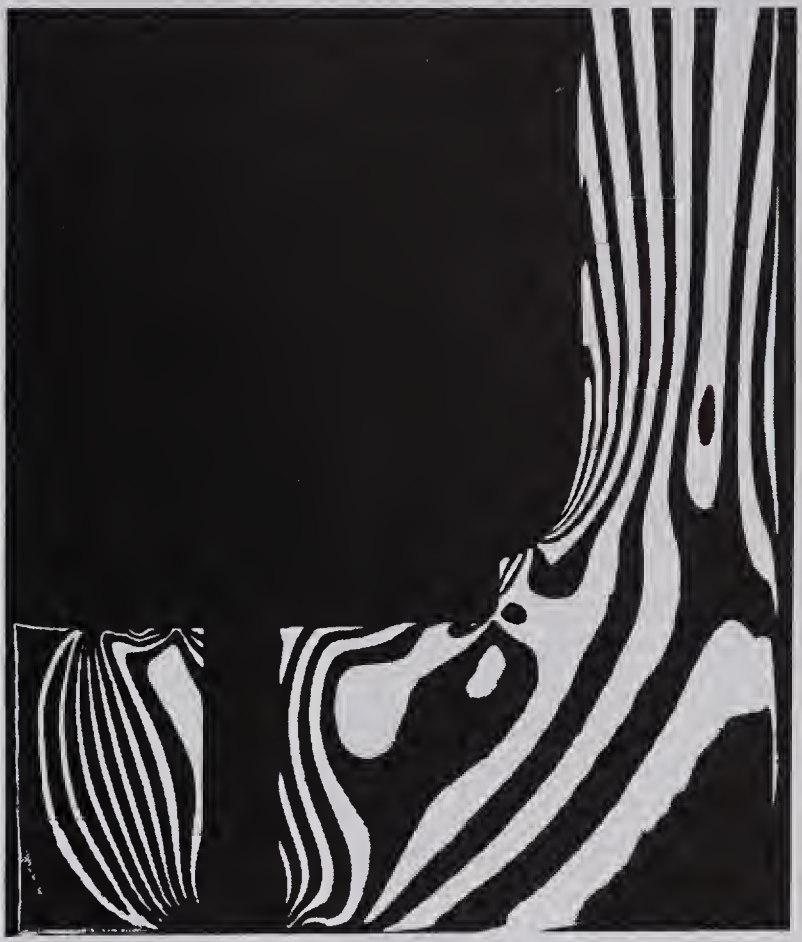

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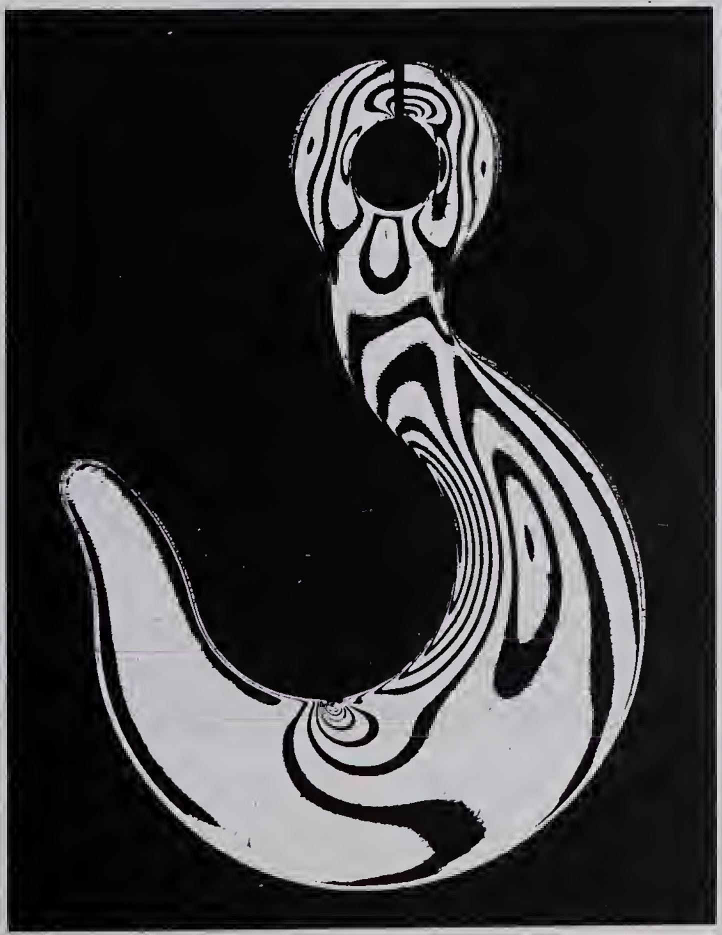
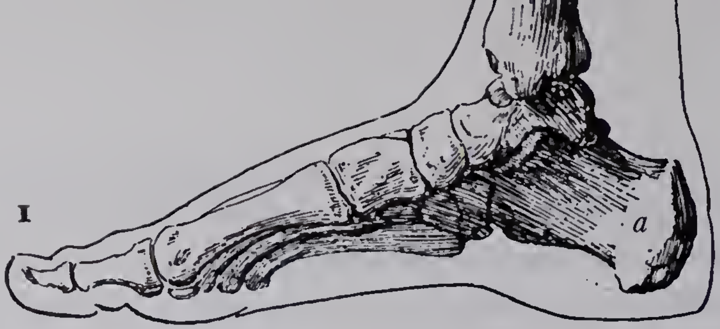


Picture **9** *is a photograph of the lines of stress inside a small machine part. Lines closely bunched together indicate areas of greatest stress. If this machine part were over-stressed a break would occur in one of those areas. It is therefore the engineer's task to design machine parts in which the various stresses will be as evenly spread as possible. In picture* **11** *you can see how this can be achieved by changing the shape of the machine part. The stress lines of the object in picture* **11** *are more spaced out than those in* **9**. *The crowding of stress lines is almost eliminated, which means that this shape has fewer weaknesses than* **9**. *It is a stronger and more efficient shape. The photograph of the crane hook,* **10**, *also shows a well-designed shape in which no part is allowed to become overstressed. More complicated hooks can be designed in their most efficient forms from a study of such photographs.*



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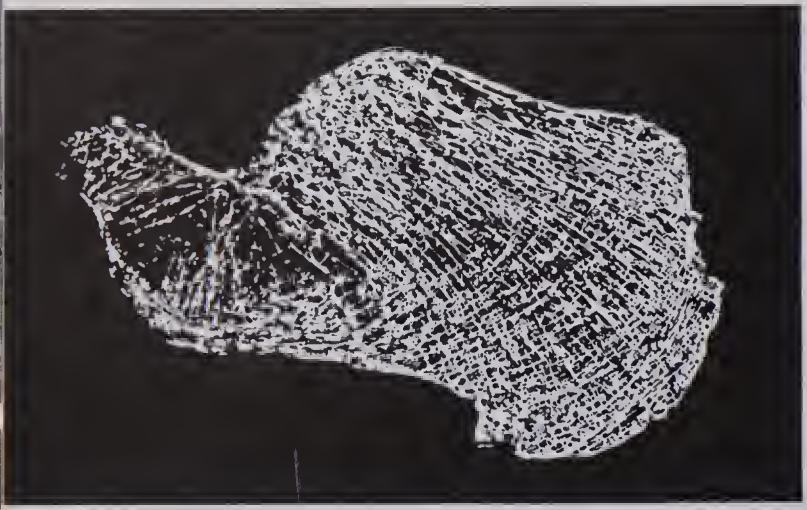

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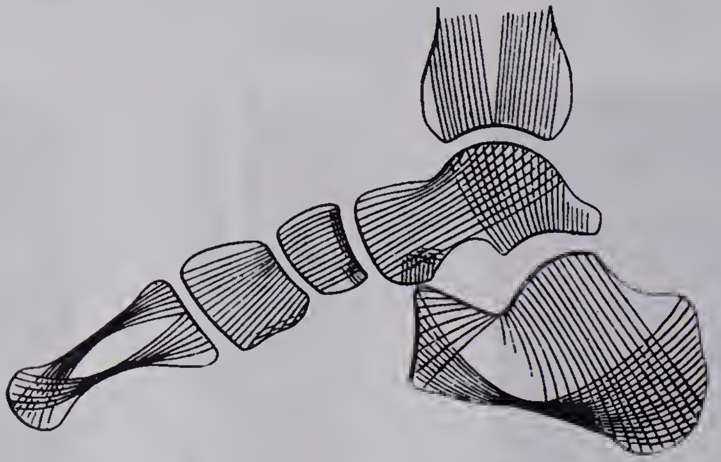
This section through the bone, marked (a) in picture **1**, *shows how its overall shape and inner structure are designed to meet its purpose, as is the case with the Firth of Forth bridge. You will notice that where no stresses occur the bone has fewer internal supports. Where the stress lines are at their densest the bone is almost solid. What do you think is the advantage of this arrangement? Through comparisons like this science can show how efficient nature is.*



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Picture **3** shows the stress diagram of the human foot. The stress lines caused by the weight of the body split in two directions: part of the stress goes into the heel; the rest is passed on through various bones forming the arch of the foot, down to the toes. Bones are shaped to withstand the stresses to which they are subjected. If you looked inside a bone you would find that it is hollow, with tiny supports stretching from one wall to the other. These supports develop in the direction of the stress lines: that is to say they are constructed to give each bone support where it is needed. Not only the shape of each bone in the human foot, but also the pattern of these supports has changed throughout man's evolution. As man's habits changed, the foot came under different stresses, and the development of the tiny struts inside each bone was influenced by the change in the direction of the stresses. If the shape of the bones had not evolved in this way the structure of the foot would have become weaker and weaker, and in the end it might not have worked as well as it does now.

Let us look at a human thighbone, which performs a task somewhat similar to the crane's. Diagram **5** shows how it is normally stressed. The bone is an infinitely more complicated device than the crane and has therefore a more complicated shape. For instance, unlike the crane it has no counterweight, for that would make it too clumsy and easily damaged. Instead

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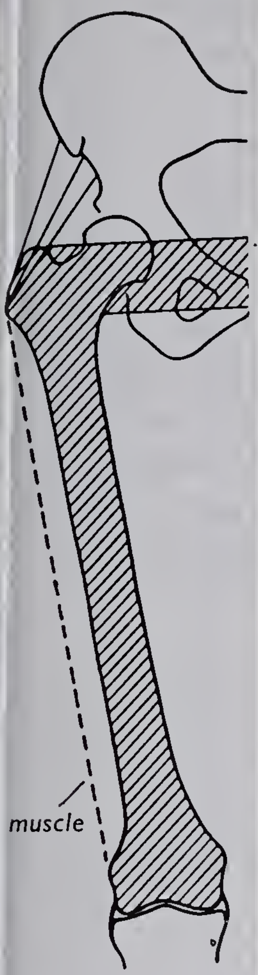

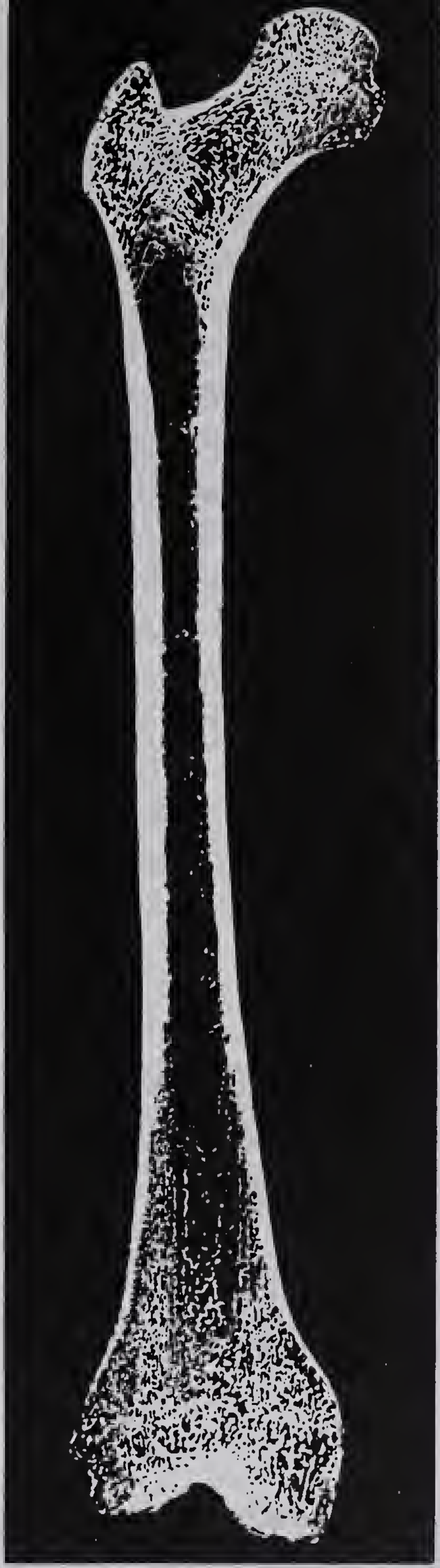

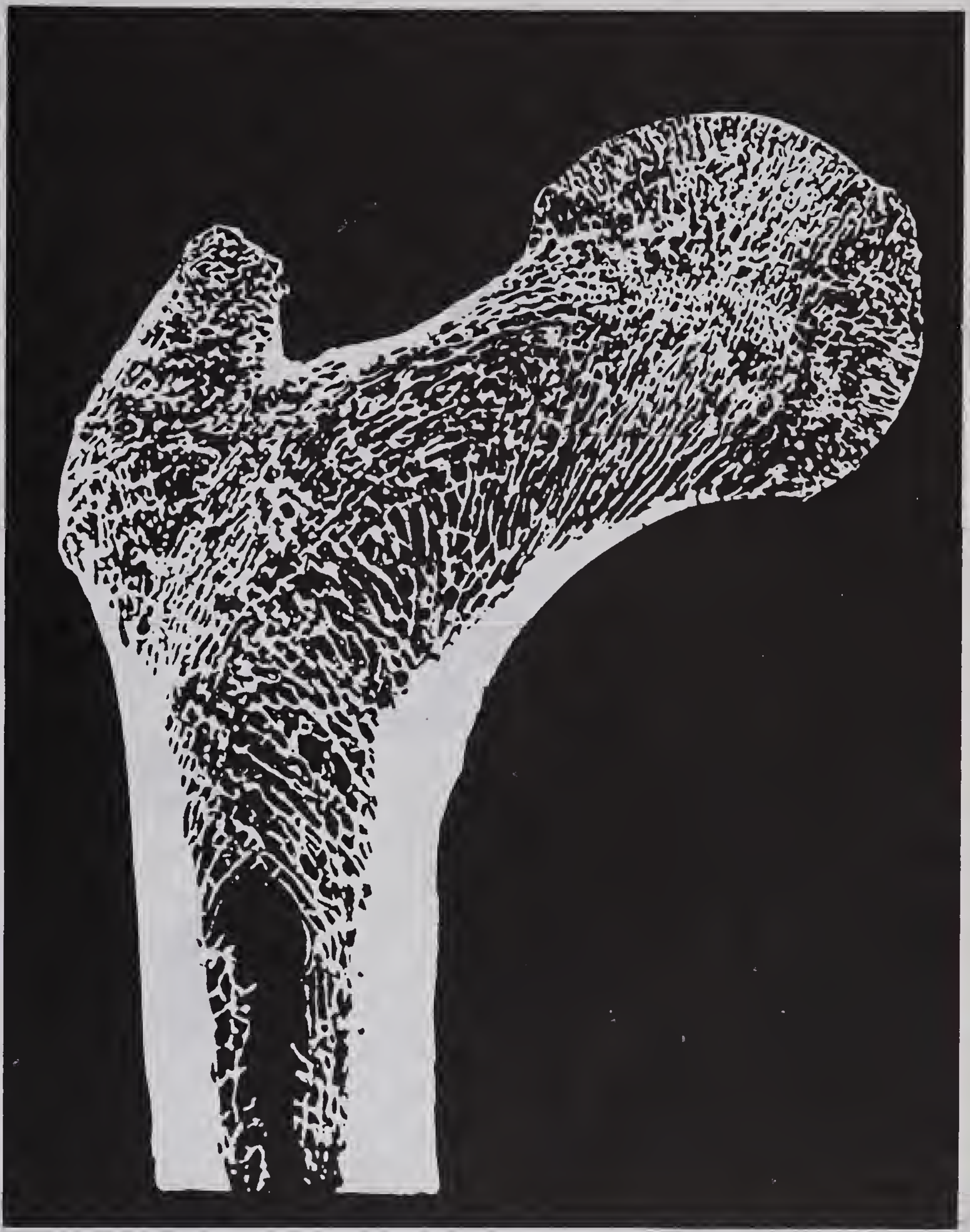

it has a protuberance, from which a muscle runs right down to the base of the bone. When this muscle contracts, thus exerting a pressure to the side of the top of the bone, it has the same effect as a counterweight. Following the principle which we applied to the last stage of the crane, **6**, the bone is hollow, and the web of bony supports inside it follows the main direction of the stresses to which it is subjected. A section through the thighbone, **6**, reveals a pattern which is very much like the diagram of forces which act on it. The shape of this bone, like that of all other bones, is the result of its adaptation to purpose. For that reason, it is an efficient shape.

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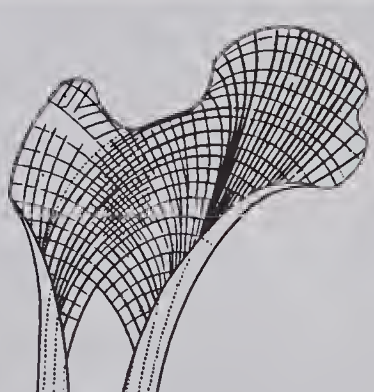
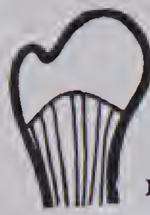


8. *Stress diagram of the human thighbone The similarity between this and the actual structure of the bone,* **7**, *is obvious.*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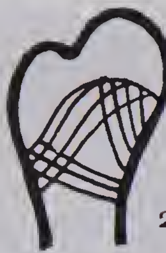
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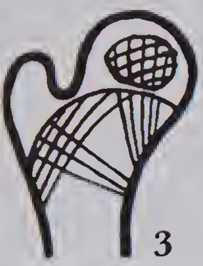
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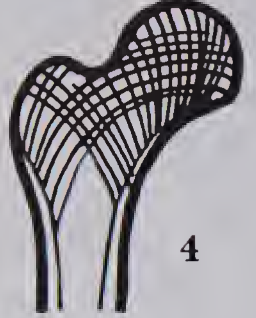
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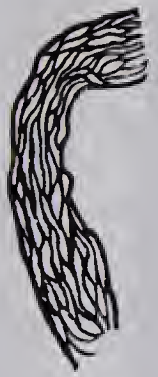
The shapes of different parts of our bodies change as we grow up. Diagrams **1** to **4** show how the head of the thighbone changes from before birth, **1**, to adult life, **4**, and how the pattern inside the bone changes with it. The reason for this is that we learn to use our limbs in different ways as we get older, and the structure of the bone has to adapt itself to these different uses. It sometimes happens that a bone is damaged and a new piece has to be inserted. This new piece of bone, from another part of the body, usually has a different structure from the damaged part, but in a short time the new piece adjusts itself to its new job and changes its structure until it falls into line with the rest of the bone and with the pattern of the stress diagram. The shapes of living things are always adapting themselves in an attempt to achieve greater and greater efficiency.

5 *shows a section through the outer wall of a hornet's nest. This outer wall must be of a certain strength, but it must also be warm and light. Compare* **5** *with the man-made brick wall,* **6**, *which would have to be about seven times thicker, and consequently heavier, to be an equally efficient insulator. The inner structure of the cholla cactus,* **8**, *is known to produce the greatest strength from the smallest possible amount of material. Nothing made by man can compete with it for efficiency. Like the radiolaria,* **7**, *and the tendril of the passion flower,* **9**, *it looks decorative to us but its structure is the outcome of its search for efficiency.*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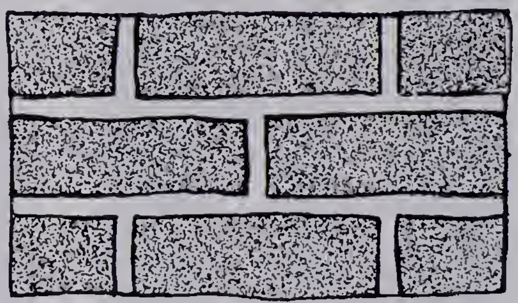
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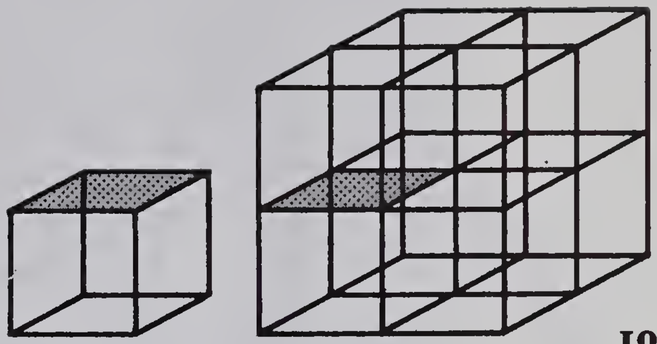
Natural shapes are never arbitrary. Even their sizes are determined by practical reasons. If you double an object's height without changing its proportion, the volume is increased eight times. The large cube, **10**, is only twice as high as the smaller one, but it contains eight cubes the size of the smaller one. On the other hand, its section is only four times greater than that of the small one. The same mathematical law applies to all bodies, including the human body. The large figure, **11**, which is twice as high as the small one, has eight times its volume, which also means that it will be eight times as heavy. But the area of the cross-section of the legs will only be four times as great. (Look again at diagram **10**.)

To support a body eight times as heavy, the legs would have to be nearly three times as thick. Such legs would be very cumbersome to use and would certainly reduce human mobility, with consequent loss of efficiency. The large prehistoric monsters, **12**, may have died out because of their inefficiency due to their excessive size. Jack (of the beanstalk) had nothing to fear from the giant, who would have been much too slow to catch up with him.

There is a best size for everything. There is also a best colour, a best pattern, and a best material. Natural shapes tend to combine all these qualities, because usually they are the outcome of efficient adaptation to purpose.



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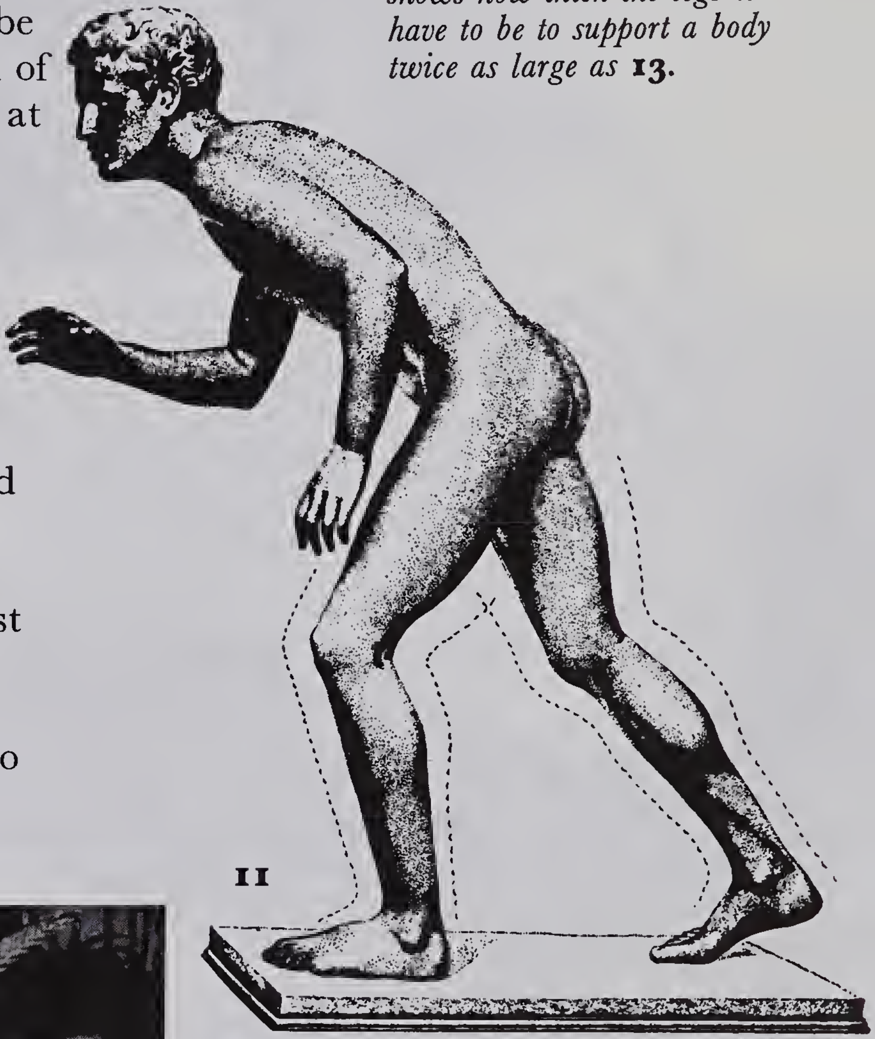
The dotted line in picture **11** *shows how thick the legs would have to be to support a body twice as large as* **13**.



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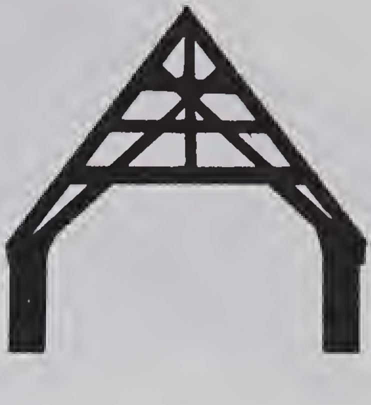

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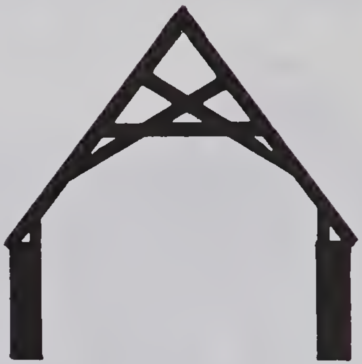

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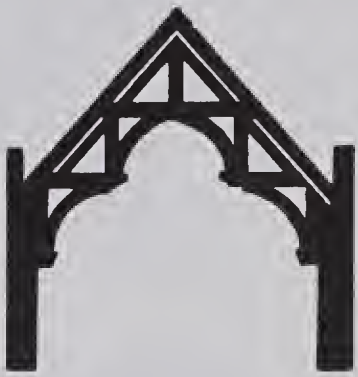
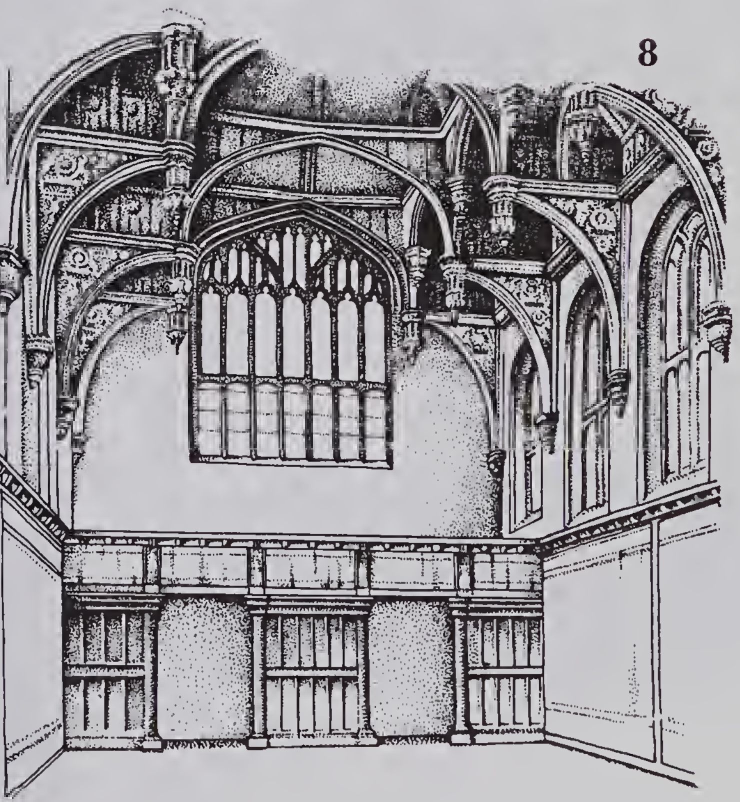


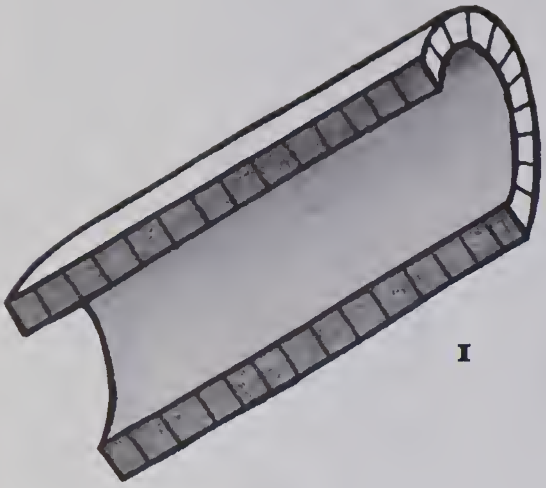
7

We have seen that man-made objects can undergo a series of changes, as natural objects do, in order to arrive at their most logical and efficient form.
The structure of a building is often shown best by its ruins, just as the structure of a leaf is clearest when all but the skeleton has rotted away. These pictures of ruins show how builders of different periods overcame the difficulties of spanning a large ground area, and in the end achieved a logical and efficient construction.
The shape of a Greek temple, **1**, was determined by the strength of its material, for the space between any two columns could be no greater than the longest possible stone crossbeam. The Gothic builder solved his problems in a different way, **2**, but he, too, depended on the strength of his materials for the shapes and sizes of his structures. Both these Greek and Gothic buildings are logical shapes but they differ from each other because the conditions which gave rise to them also differed. The Greek builder had vast stores of stone and marble, with a great force of slave labour to quarry and work them. The Gothic builder, with less labour available, had to devise methods to use the least amount of building stone.

The Greek temple, **3**, *and the Gothic church*, **4**, *derive their shapes largely from different methods of spanning the ground plan.*
The development of the hammerbeam roof is similar to the development of the most efficient square frame (page 45). Although **5** *is a good structure for a wooden roof in a hall or a church, it obscures the important east window.* **6** *interferes less with a clear view of the window but is less strong. The hammerbeam roof,* **7**, *is structurally sound, and, as at Hampton Court,* **8**, *far from obscuring the view, actually supports the shape of the window.*

8





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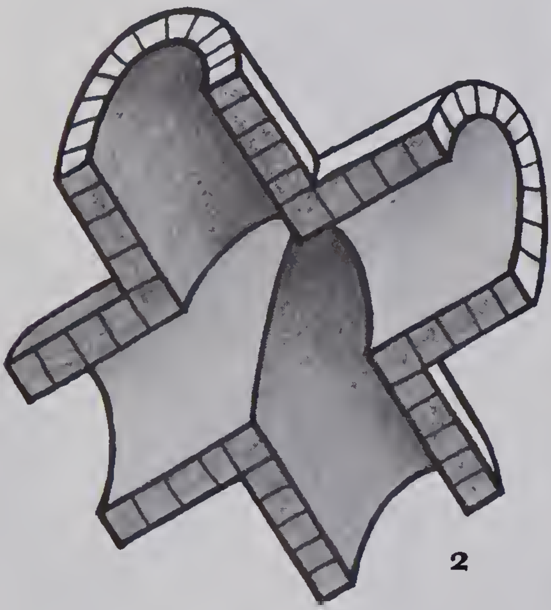

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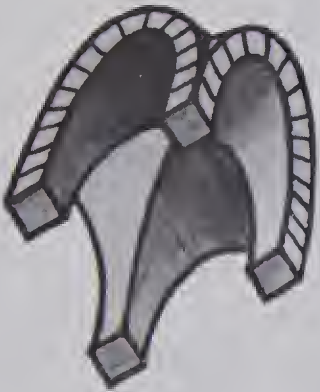

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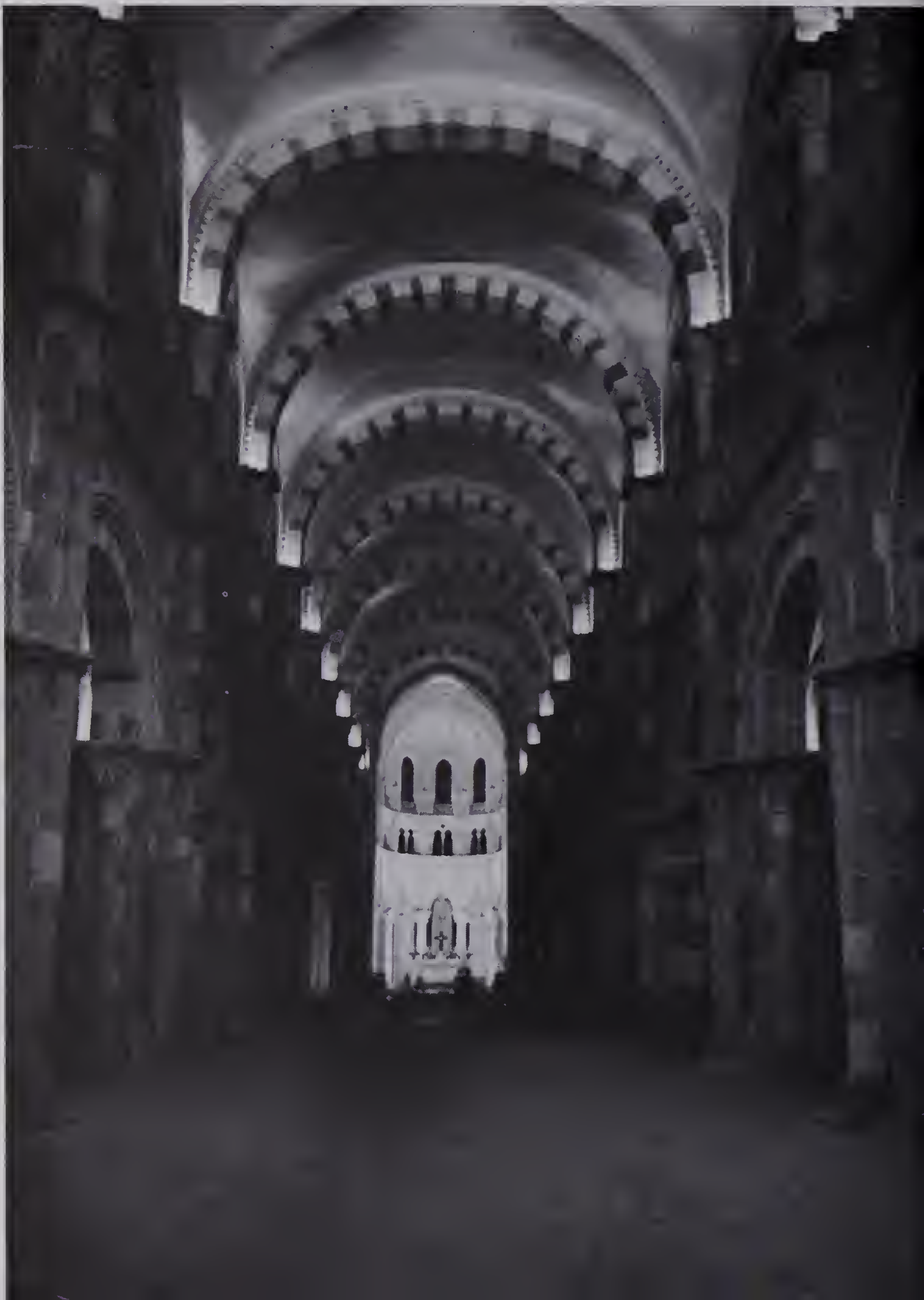
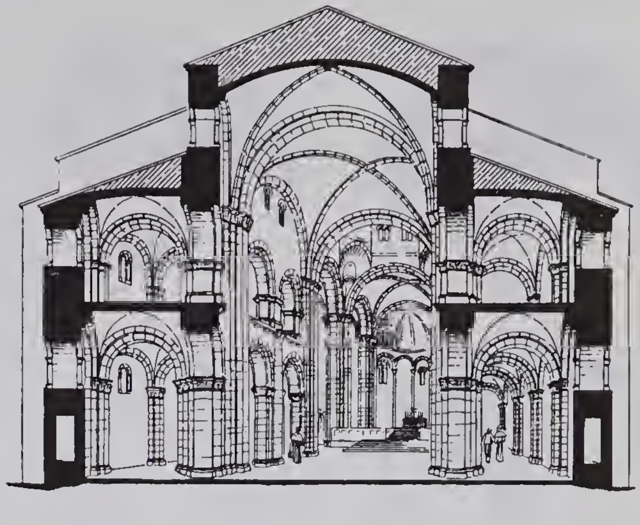
To understand how the Gothic way of building came about we must start with the Roman barrel vault, **1**, in which large blocks of stone, cut to the right size and shape, supported each other to form a tunnel-like structure. Where two such tunnels crossed, a cross vault, **2**, had to be constructed. It was soon found that these cross vaults were much more useful than the barrel-like vaults, for, raised on pillars and repeated again and again, they could cover a large area, **4**. This allowed a more spacious structure and was used effectively in the great Romanesque churches. Because such a roof structure required a great



4

number of thick blocks of stone, the walls and the foundations also had to be very thick, and the number and size of windows had to be kept to a minimum. This style of building had the advantage of great strength in times of insecurity. The aspect of such a church, dominating a town with its massive strength, **6**, must have been reassuring to the inhabitants. By imitating only the crossing of the Roman barrel-vault, the Norman builders had in fact taken its weakest part and left out its strength. In order to improve the vault where it was weakest they started to build up the groins as independent arches, as shown



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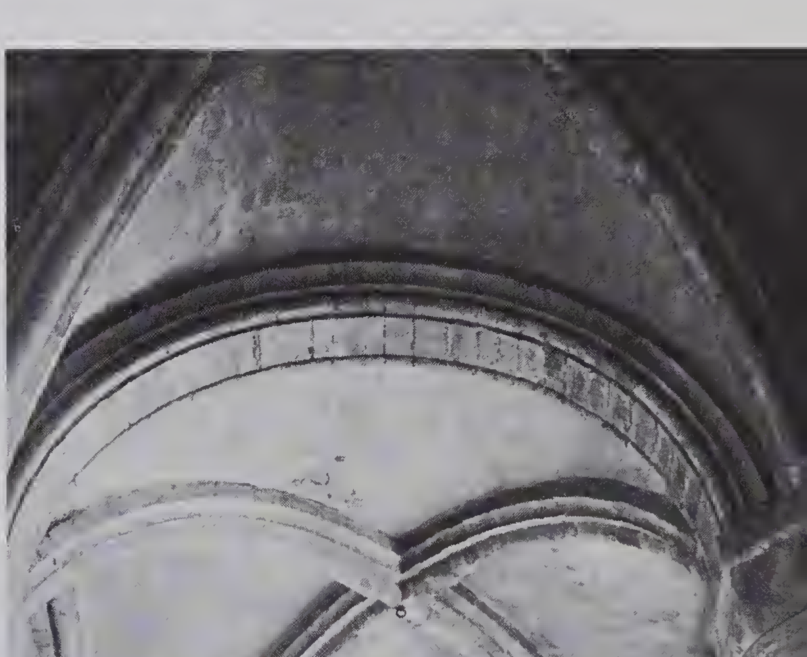
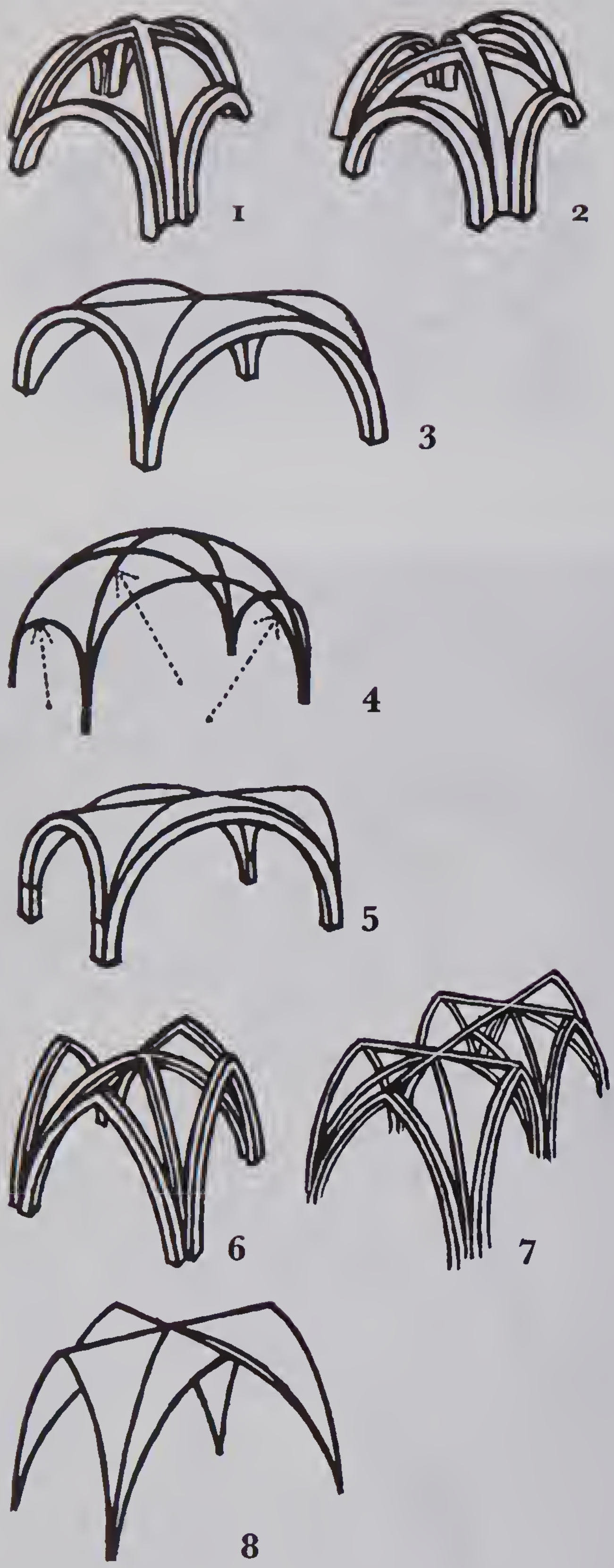


6 7

5 and 7 show how individual vaults were combined to form larger roof structures.



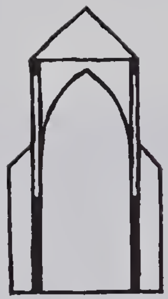
1 and **2** *show arches and groins only,* **3** *shows the completed and filled in form of* **2**. **4** *shows only the different radii,* **5** *is again a completed vault, on stilts.* **6** *and* **7** *show the main structural members of the Gothic vault,* **8**, *the simplicity and strength of the same vault.*

in **1**. In this way they were able to build a much stronger roof, and they also learnt how to do it with less material, for it was now possible to fill in the spaces between the arches with thin slabs of stone instead of the big blocks of the Roman vault. The fact that such roofs were easier to make and used less material was of great importance, for as times became more secure, cheap labour was far less easily available and this made materials scarce and costly.

But such roofs still had many disadvantages. They looked clumsy because they were broken up into a series of hemispheres and it was difficult to fill in the spaces between the arches, because these were of varying heights, **1**. To get over the difficulty of arches of different heights, the groins were flattened to bring their tops down to the level of the other arches, **2**, but this weakened the groin. When the ground plan of a vault was oblong instead of square, there were arches of three different radiuses in each vault, **4**. This was not only structurally unsound from several points of view, but it also looked wrong and awkward. The only possible compromise was to flatten the groin arches and to raise the smallest arches on stilts, **5**, but this again was a poor solution. The arches did not end at the same point and could therefore provide little support for each other. There were other drawbacks as well.

For various reasons, which we shall discuss later, men now wanted to build higher and yet higher churches and spires. To increase the height of a Norman church would have required walls and foundations of such enormous thickness as to make the whole thing an impossible dream.

There was one answer to all these problems: the pointed arch. Figures **6** and **8** show how pointed arches can be made to reach the same height, even if their spans vary, and how such units can be joined to form one strong structure, **7**. The line of the roof can now be carried along in one continuous straight line, which is pleasant to look at, **12**. Because the Gothic vaulting system is structurally sound, its appearance is good, **8**. While the Gothic vault was evolving, other developments were also taking place. The outside walls of large buildings like churches were strengthened by supports called buttresses, **9**, which helped to take the outward thrust of the roof. As bigger and bigger churches were needed, aisles were added at the sides of the nave. The admission of enough daylight to such a large area then became a problem. The walls of the nave were made higher, to allow a row of additional windows, **10**, which became known as a clerestory (clear story). To make room for the aisles a new kind of buttress had to be invented: the flying buttress. This carried the thrust from the roof right over the tops of the aisles and down sturdy pillars into the ground, **11**. Small towers, called pinnacles, were placed on these pillars to weight them down and give them additional strength to withstand the thrust. Since the walls themselves now supported much less weight, thanks to the flying buttresses, they could be made thinner and be pierced with larger and larger windows.



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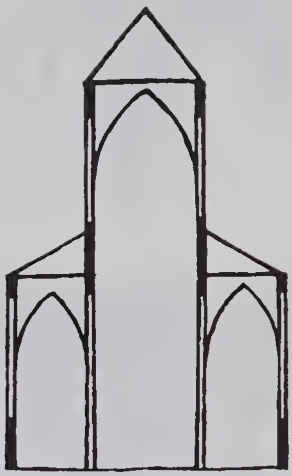

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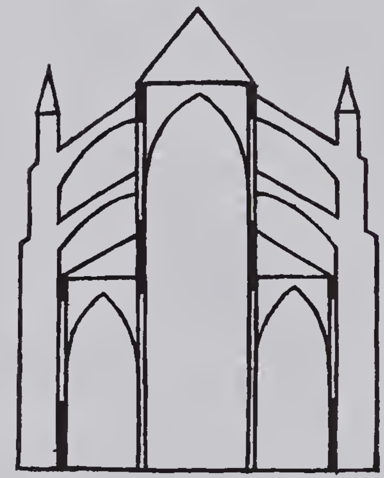

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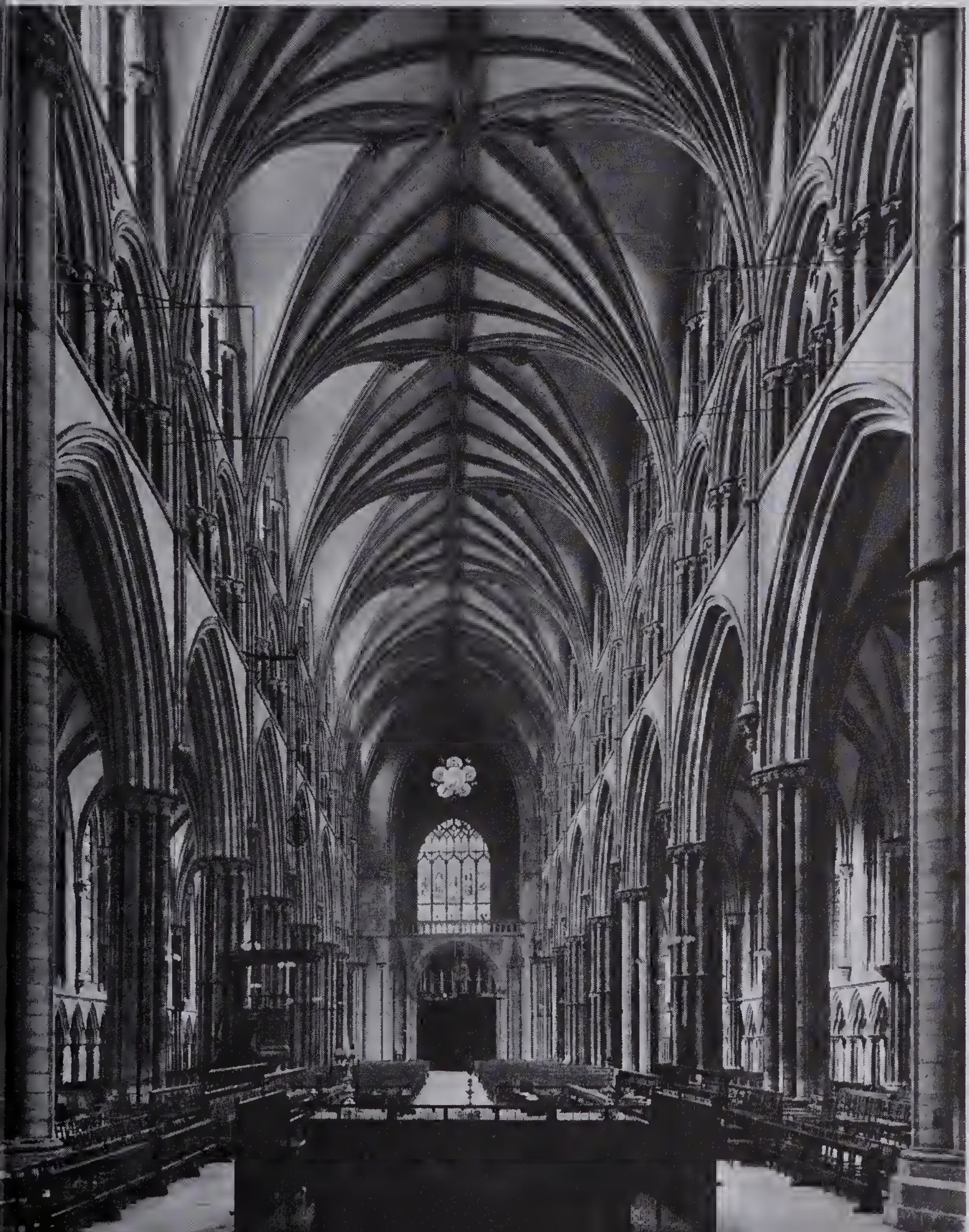
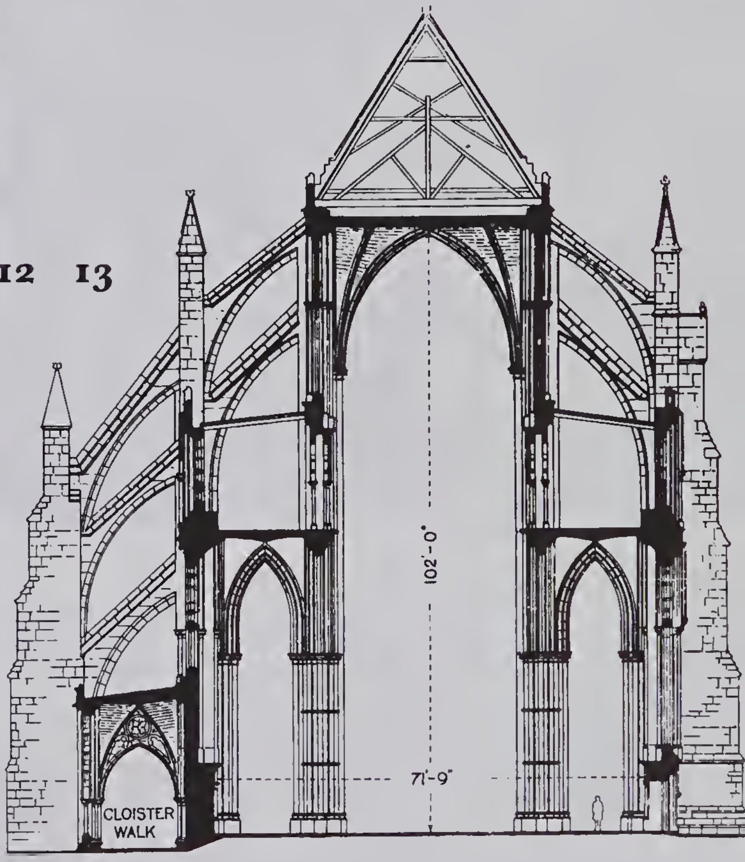
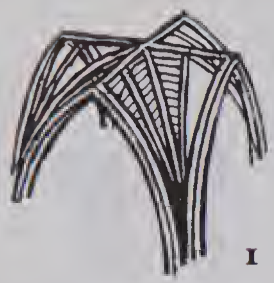


12 **13**

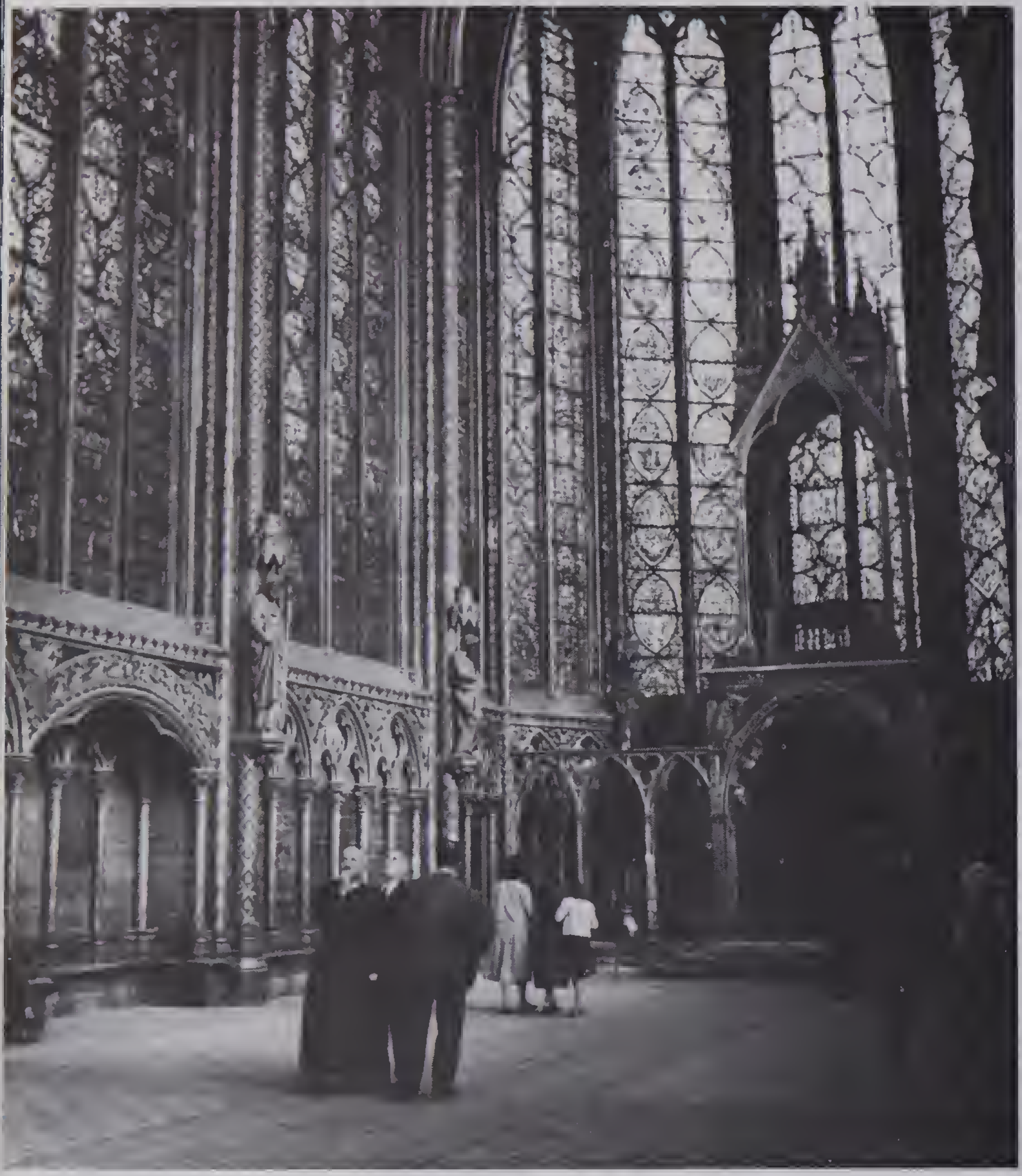


12. *This picture shows the even roof line of Gothic vaulting. Compare it with picture* **4** *on page 54.* **13.** *Westminster Abbey has two rows of flying buttresses on one side to pass the outward thrust of the roof over aisle and cloister walk.*


1

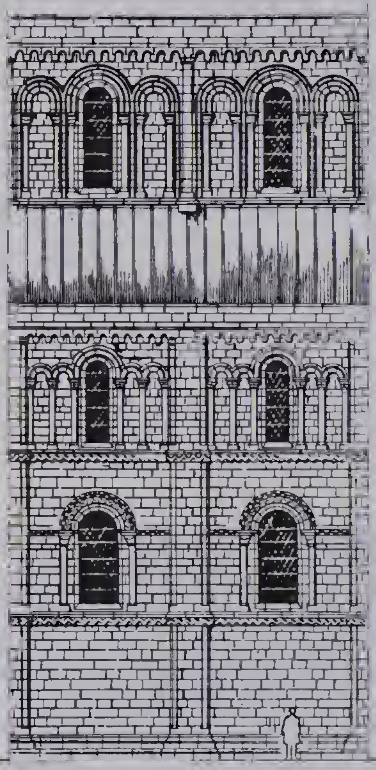
Methods were found of adding ribs to the Gothic vault, **1**, which meant that still smaller and thinner panels could be used for filling in spaces between the arches. This allowed the whole of the building, roof and walls, to become lighter still. In the end, hardly any solid wall remained, as in Sainte Chapelle in Paris, **2**. All this fitted in with the needs of the times, for the purpose of the church had changed from a haven of refuge to a monument to the glory of God, and also to the prosperity of the community. No system of building could have expressed this purpose better than the Gothic.

2



So obsessed were Gothic builders by the idea of using as little masonry as possible that they sometimes resorted to iron reinforcements to hold the slender stone supports together. Such reinforcements were found in the walls of Sainte Chapelle. We can therefore say that the Gothic builders anticipated the building methods of our own times.

3



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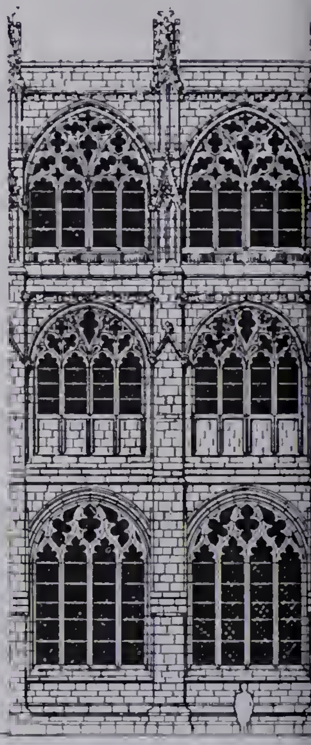
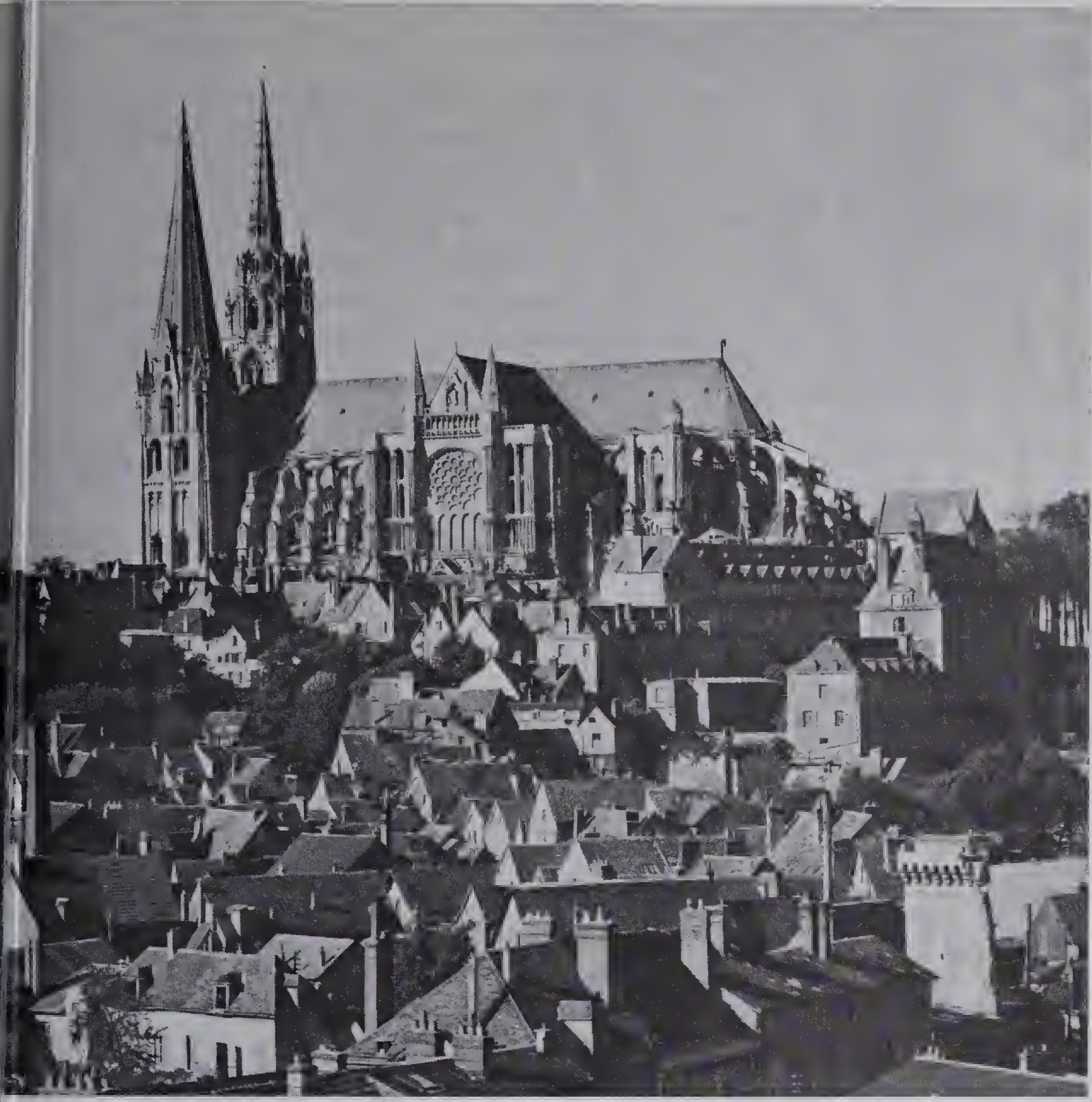


3. *Romanesque windows* 4. *Late Gothic windows*

The Gothic church, **5**, *looks quite different from the earlier Romanesque one,* **6**, *but the architects who built the Gothic church did not suddenly decide to build in a different style. The difference in appearance is accounted for by the gradual changes we have been discussing in the last five pages.*



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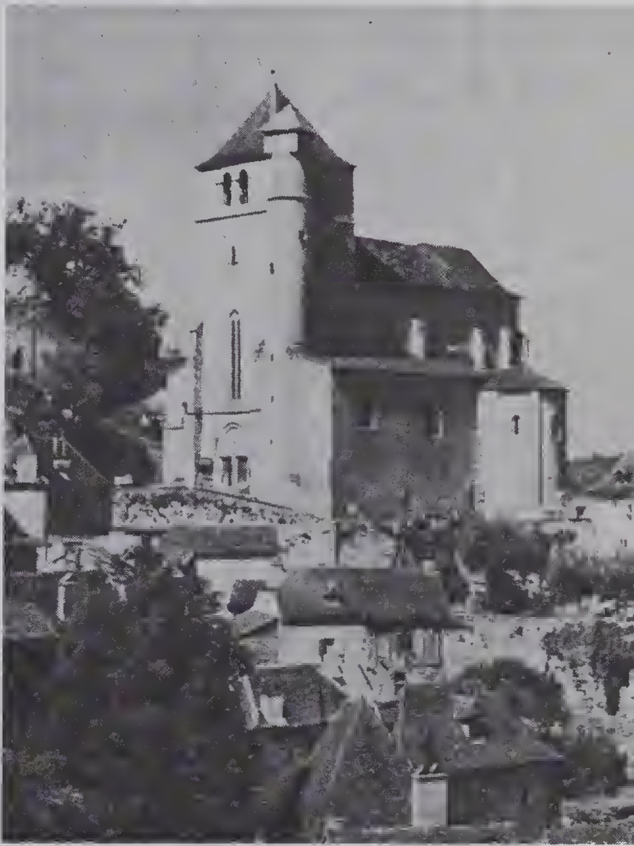
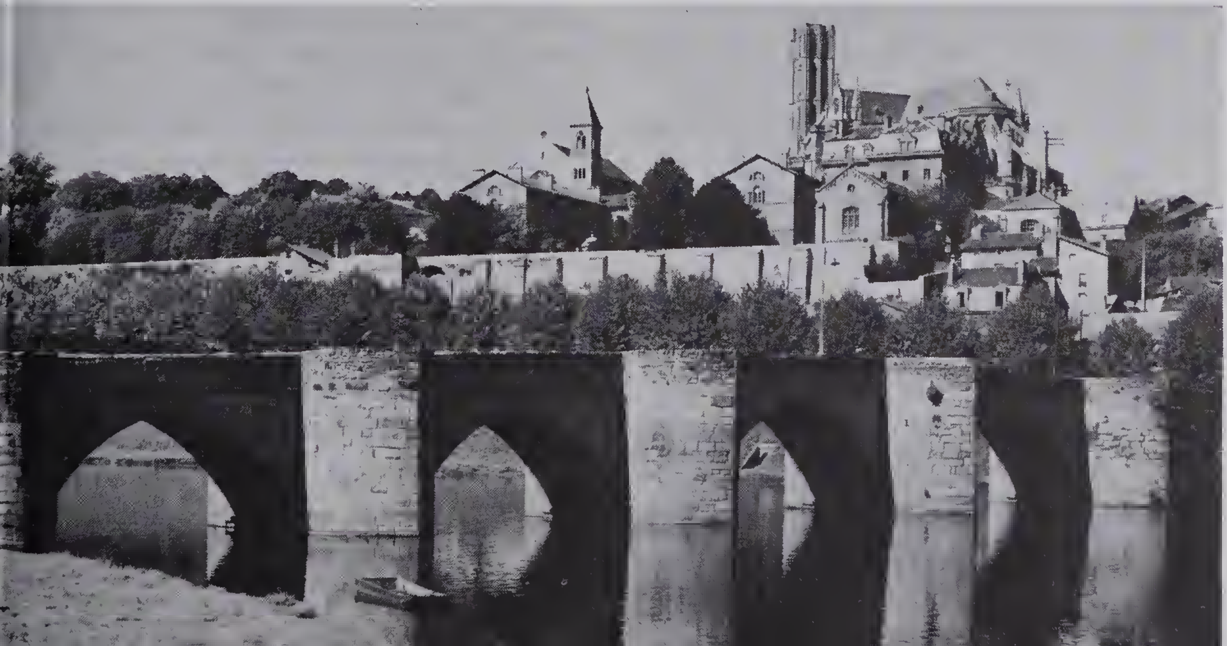


6

The Gothic cathedral is a logical and efficient shape. Its development and its final shape have something in common with those of natural objects. The Gothic cathedral 'grew' its pointed arches, its buttresses, its flying buttresses, and pinnacles, much as the bone grows its own internal structure of resistance to stresses. The Gothic style of building worked so well that for over two centuries it scarcely changed.

Although the Gothic style is largely associated with churches, it was above all a practical method of building; bridges and houses also made use of the pointed arch, **7**, **8**.

7



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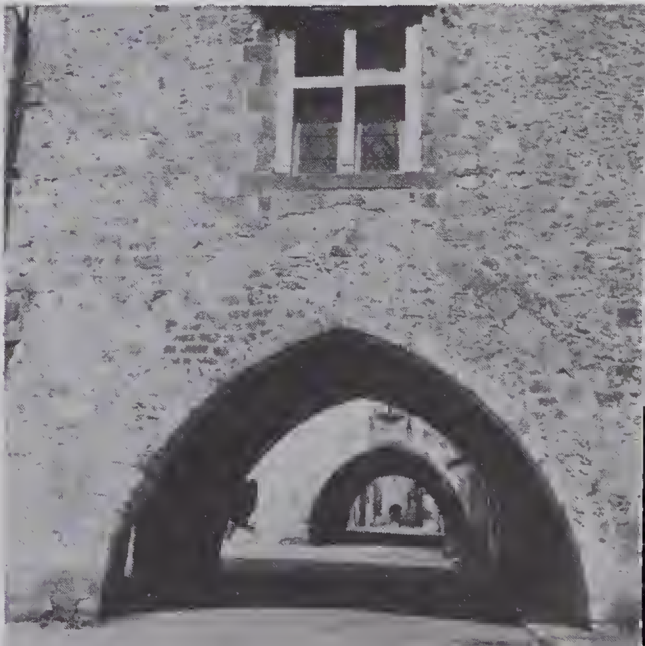

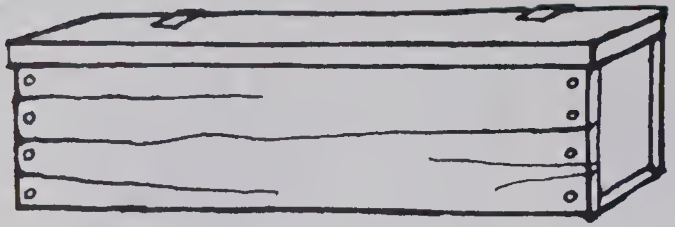

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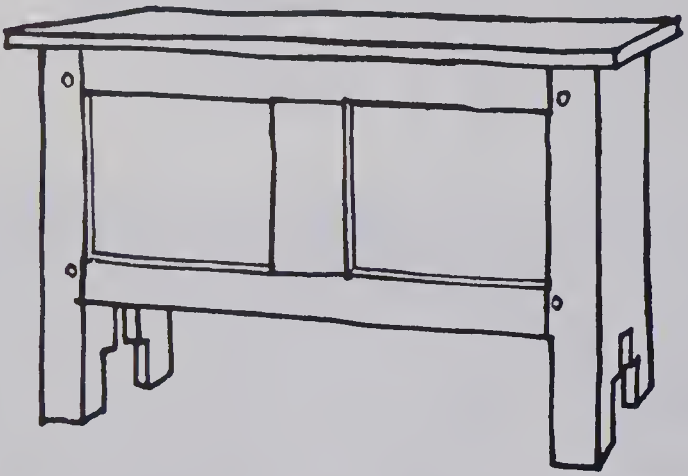
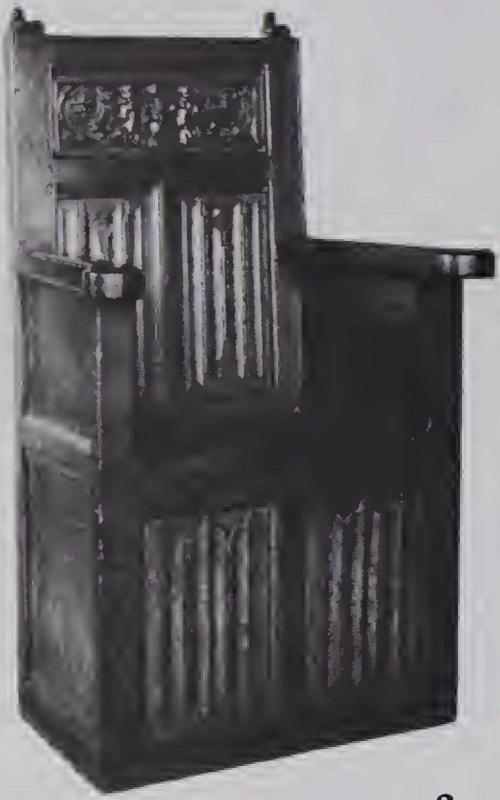


2

We are already familiar with two factors which determine the shapes of both natural and man-made objects: materials and the forces acting on them. A third influence, as we can now see, is the purpose to which the object will be put: its function. Shapes well suited to their purpose may be called functional shapes. Many tools, buildings, and the shapes of nearly all living things are functional. A crane or a Gothic cathedral or a human foot are functional shapes.
If we wish to appreciate such shapes, whether natural or man-made, we need to know the history of their development. Pictures **3** to **7**, for example, which describe the development of the chair, help us to understand the modern chairs which we looked at on pages 30–31.



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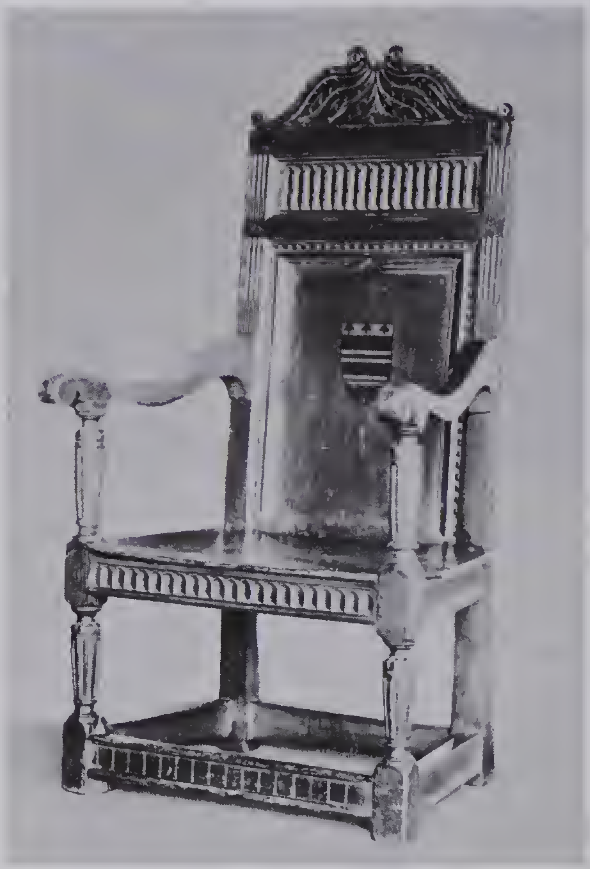

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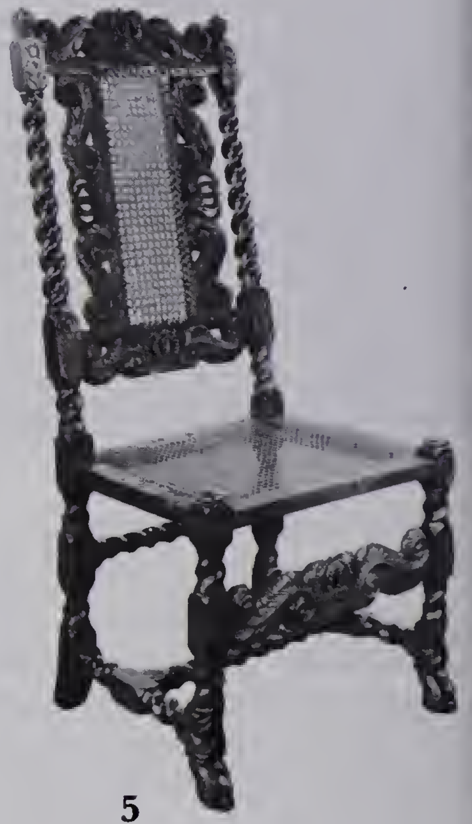


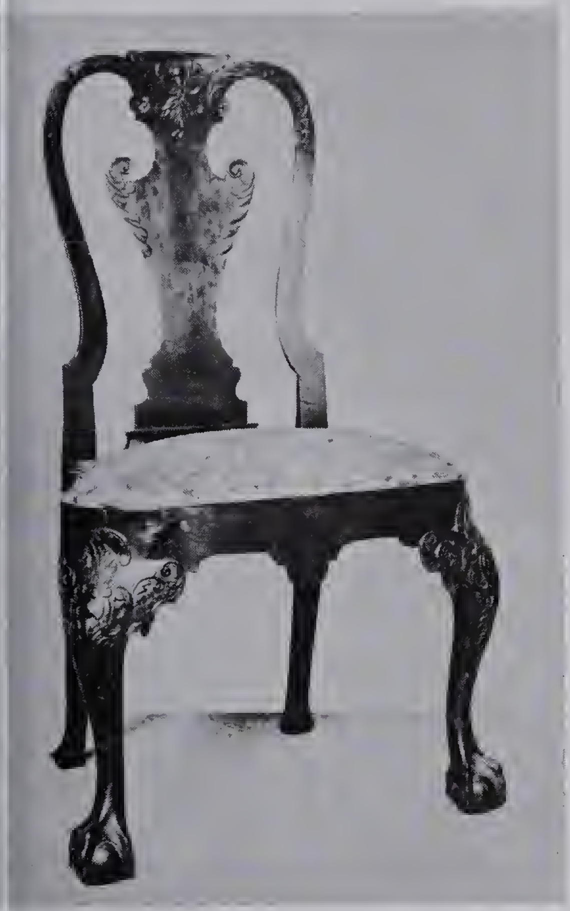
5

3. *A box chair made in 1540 derives much of its construction from the chest. Early chests,* **1**, *were simple boxes made of oak, nailed together at the corners. Because oak tends to shrink, the panels often cracked where they were nailed down. The introduction of the frame and panel construction,* **2**, *prevented cracking, for the panels could move freely within the frame. This was the only good construction the joiners of the period knew how to make and the box chair shape was the best they could achieve.*

4. *By about 1600 people realised that panels were not necessary to a chair. The framed-up chair was the result. It was still joiner-made and heavy, but it could be moved about more easily than the box chair.*

5. *After the austere years of the Commonwealth, people wanted decorative things about them. The basic construction of this chair made about 1680 is still very similar to that of its forerunner,* **4**, *but it is much more highly ornamented and less solid looking. The foreign fashions brought back with the restored monarchy pleased people in search of gaiety, and the new taste for foreign woods, such as walnut, made lighter, finer furniture possible. Th chair could not have been made of oak, which would not have allowed such delic and intricate carving. Neither could it ha been made by a joiner, like* **3** *and* **4**. *Th reconstruction of London after the Great Fire of 1666 created a need for many ne things, and new skills were developed to meet the new demands. Among these skil was the cabinetmaker's trade.*

The eighteenth century saw the arrival in gland of a new timber, mahogany. This in many ways the perfect wood for rniture making and it had a good luence on the design of furniture. Take a se look at this chair. It marks the height a great period in furniture making. It ks comfortable and at the same time ht. The ornaments are part of the ucture of the chair and are not added rely as an afterthought. Look especially the elegant curvature of the arms, signed to fit the human frame.



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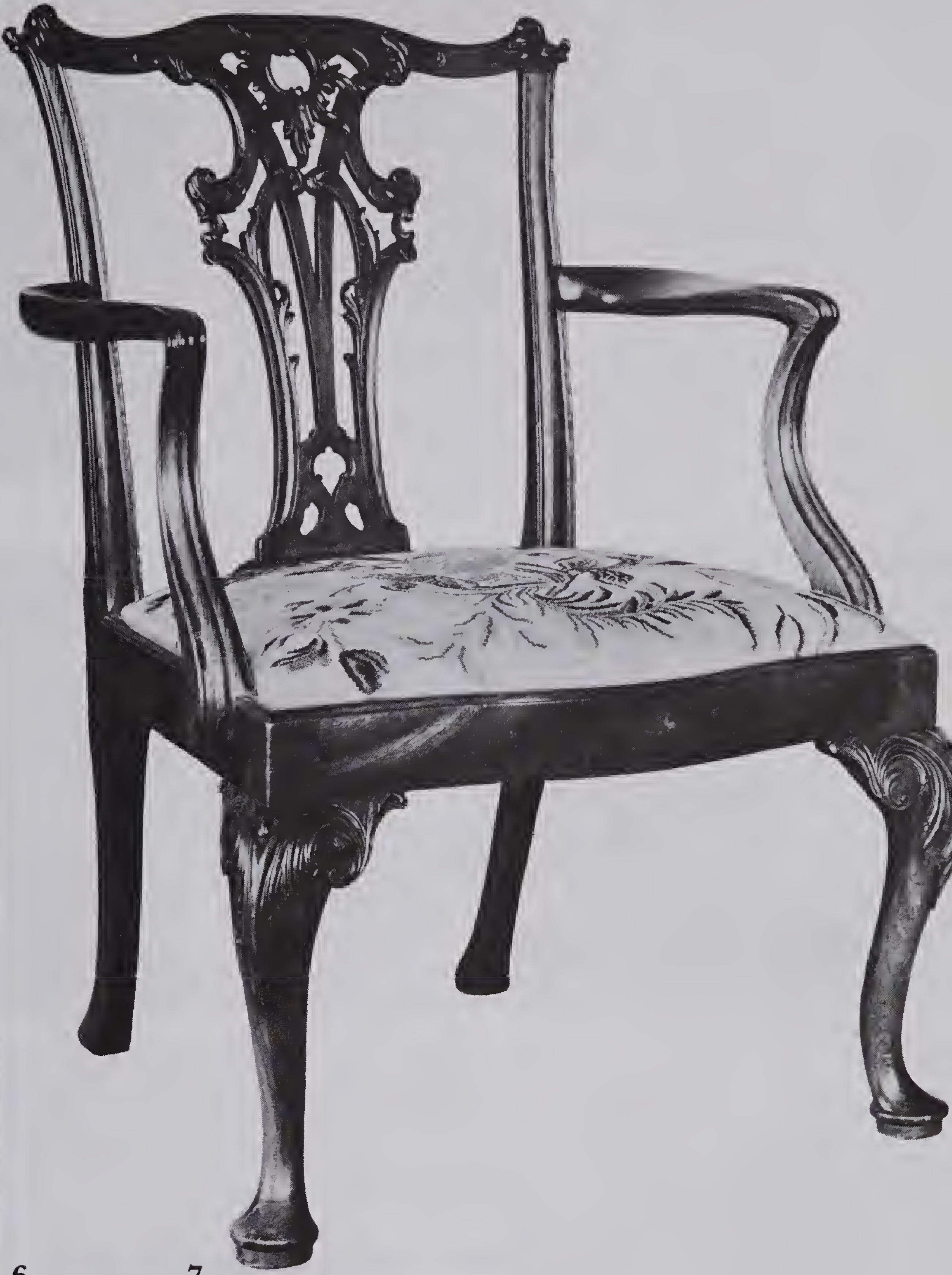

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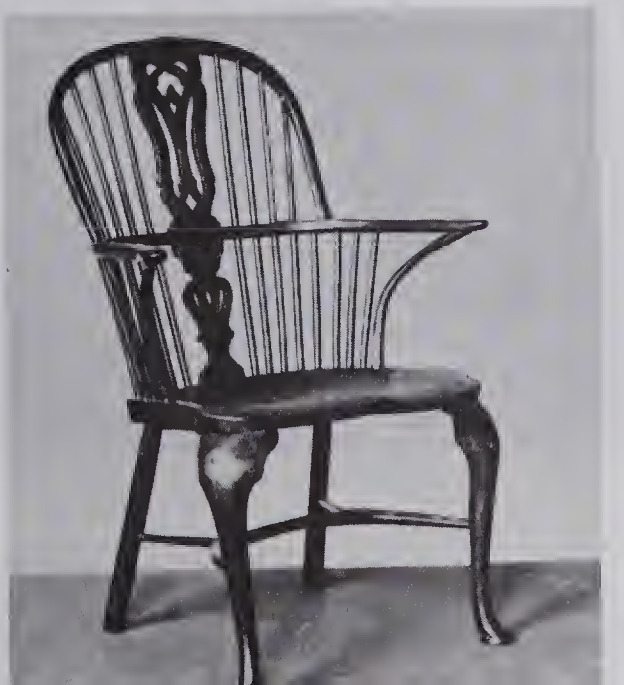
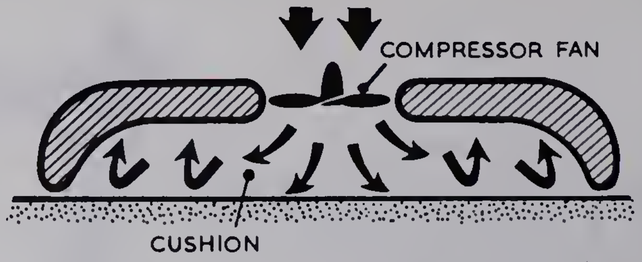
. This chair was made early in the ghteenth century and is the first real chair-hape. The over-emphasis on decoration in is abandoned in favour of greater ttention to construction. By making use of number of curvatures in the right places he structure of the chair is strengthened, so hat the pieces of wood which supported the egs can be omitted. Ornaments are estrained and are used to embellish the hair, not to overpower it. The craftsmen of he period had found a good shape and vere proud of it.



8. *This beech chair made at about the same time as* **7**, *does not attempt to imitate the refined workmanship of the cabinetmakers. It was made in the country, of a material found in the neighbourhood. Country people had different needs from townspeople, and they did not have at their command the specialised skill of the town craftsman. Their materials also were different. This chair, made for them, bears out all these facts.*

Often we can see a functional shape in the making. For example, efficient shapes for the hovercraft and the cushioncraft are now in the process of being developed. At the moment different ideas, **1**, **2**, and different shapes, **3**, **4**, and **5**, are developing side by side and nobody can say at this stage which of these will prove to be the most efficient. But one thing is certain: the final shapes will be quite different from anything that has ever been seen before because the principles of the hovercraft and the cushioncraft are new.



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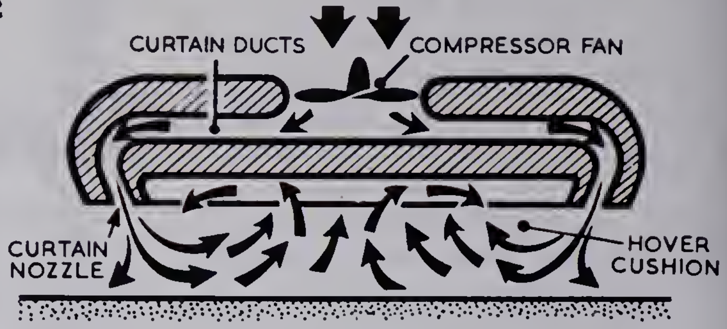

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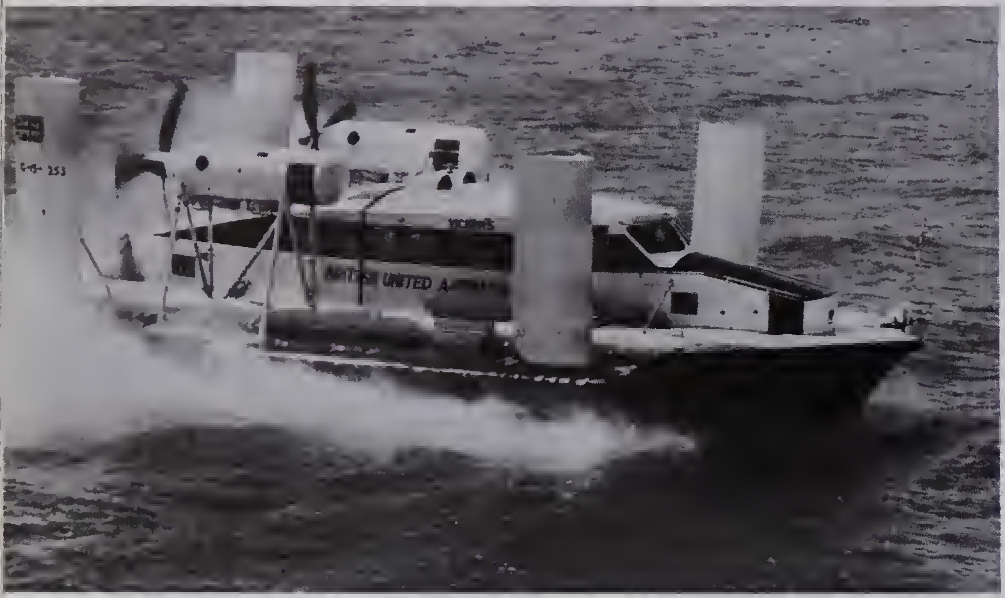

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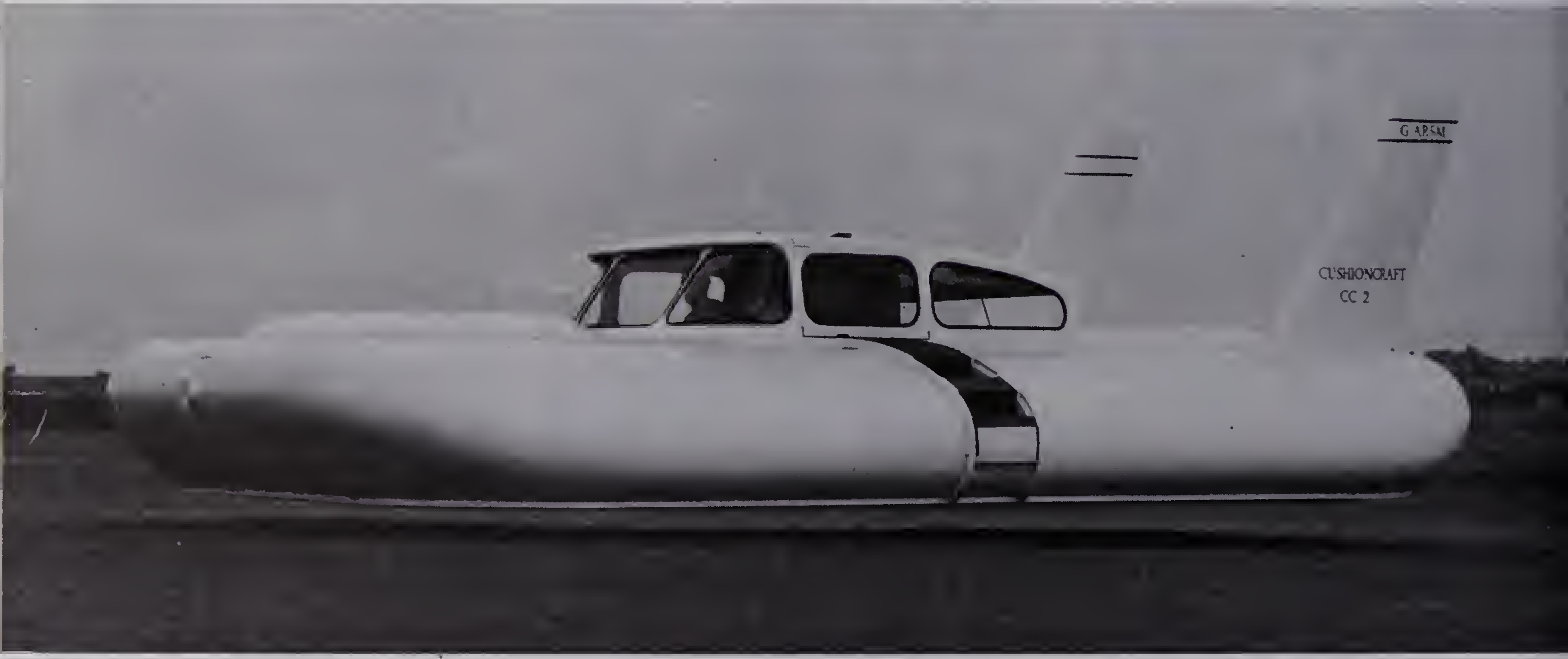

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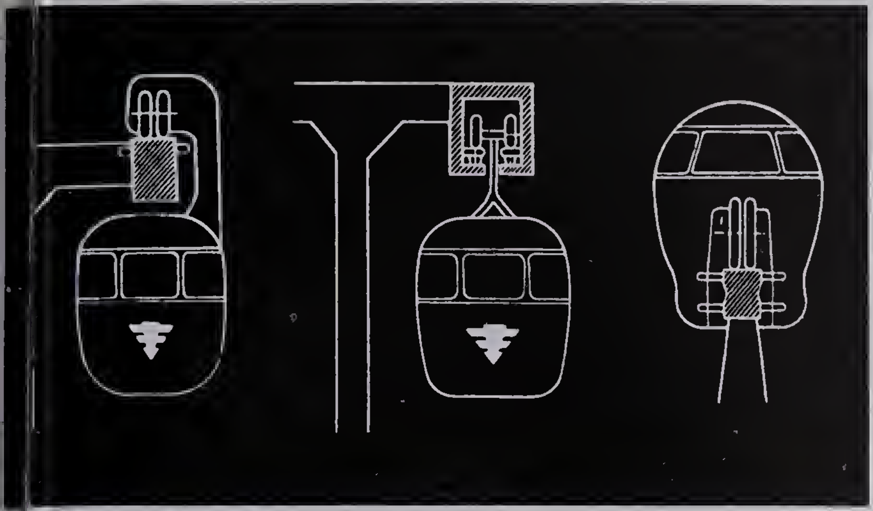

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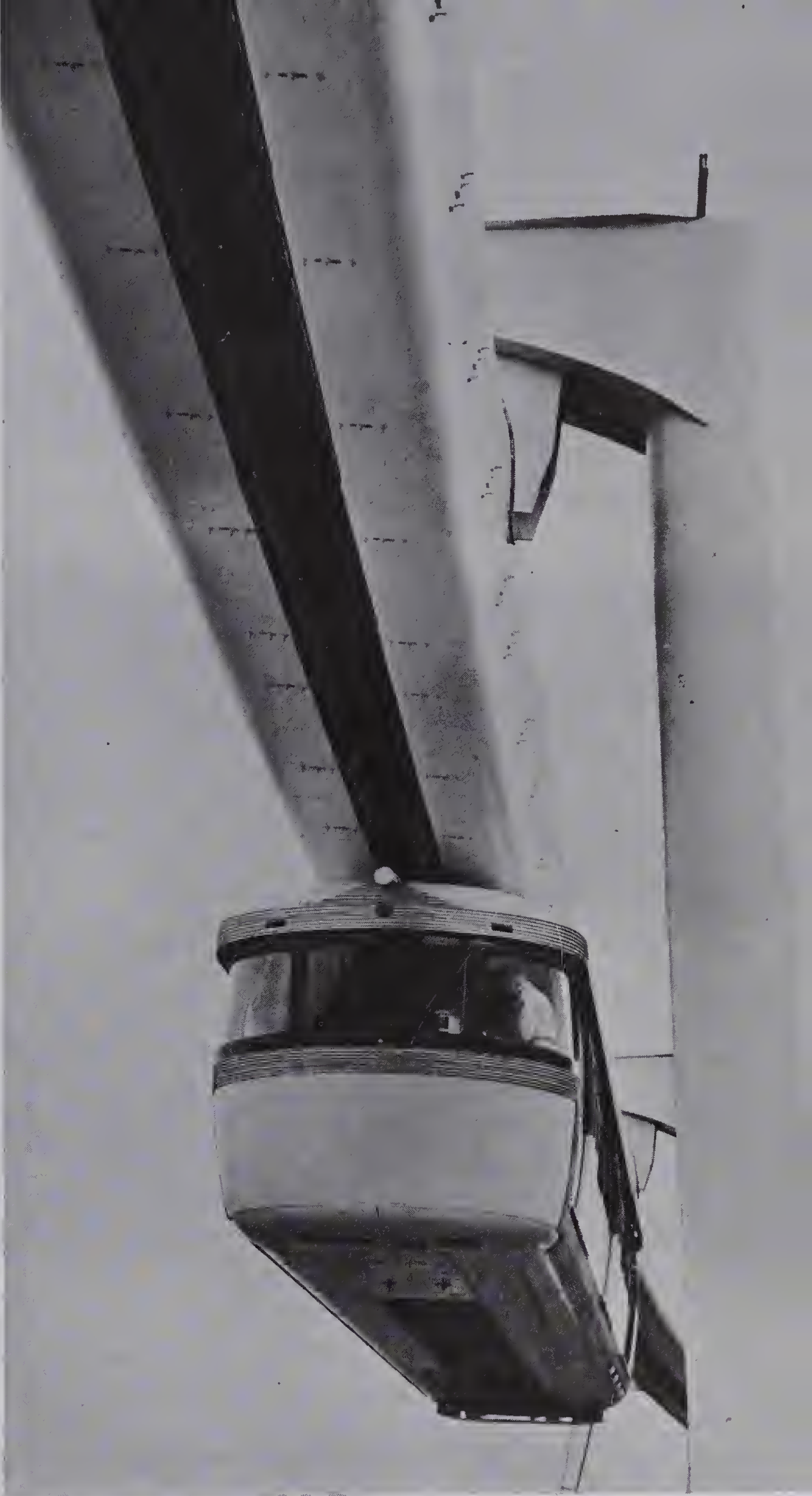

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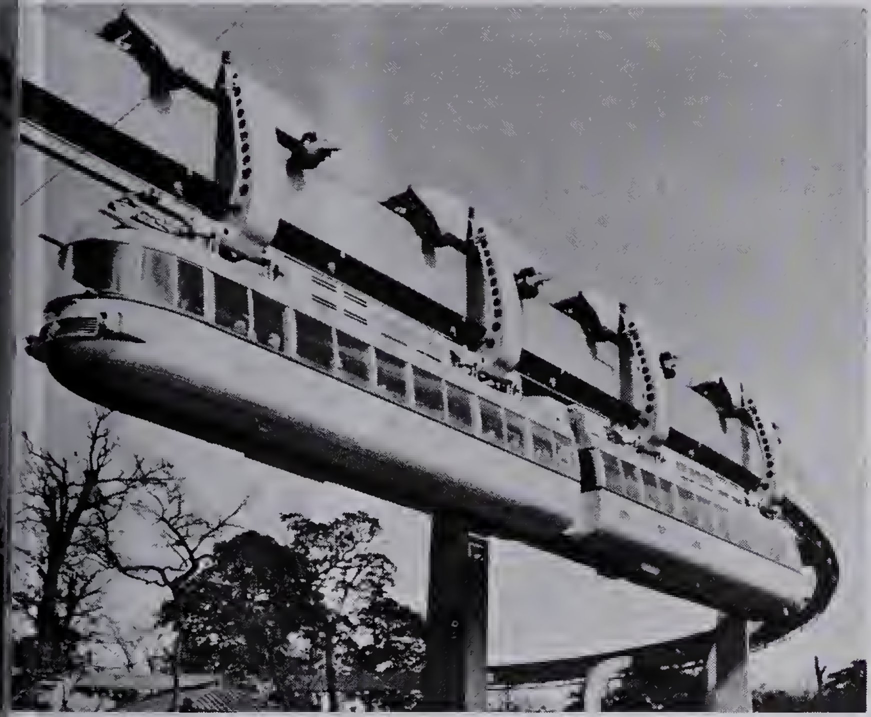
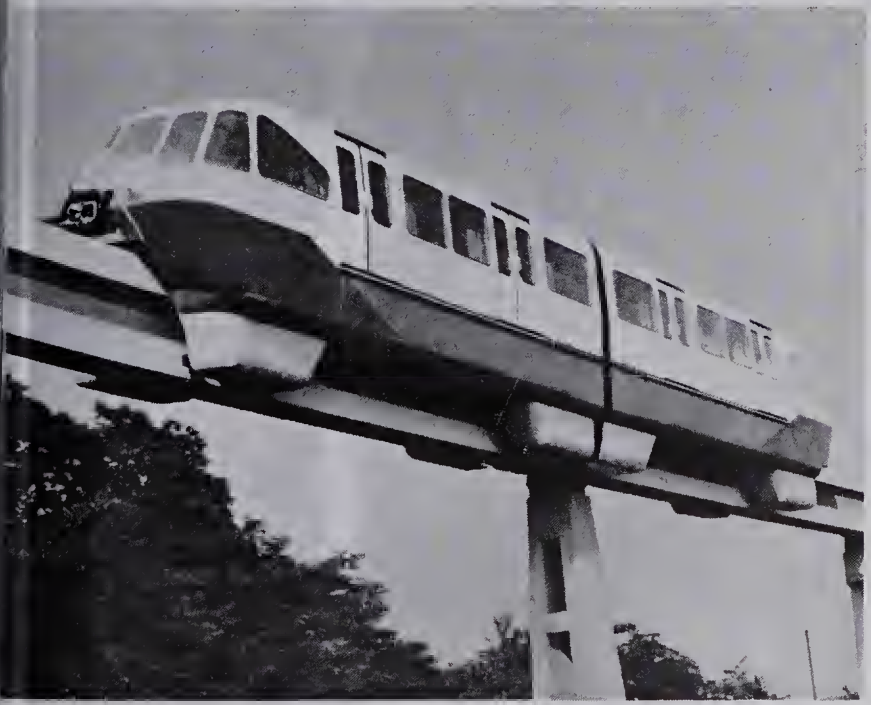




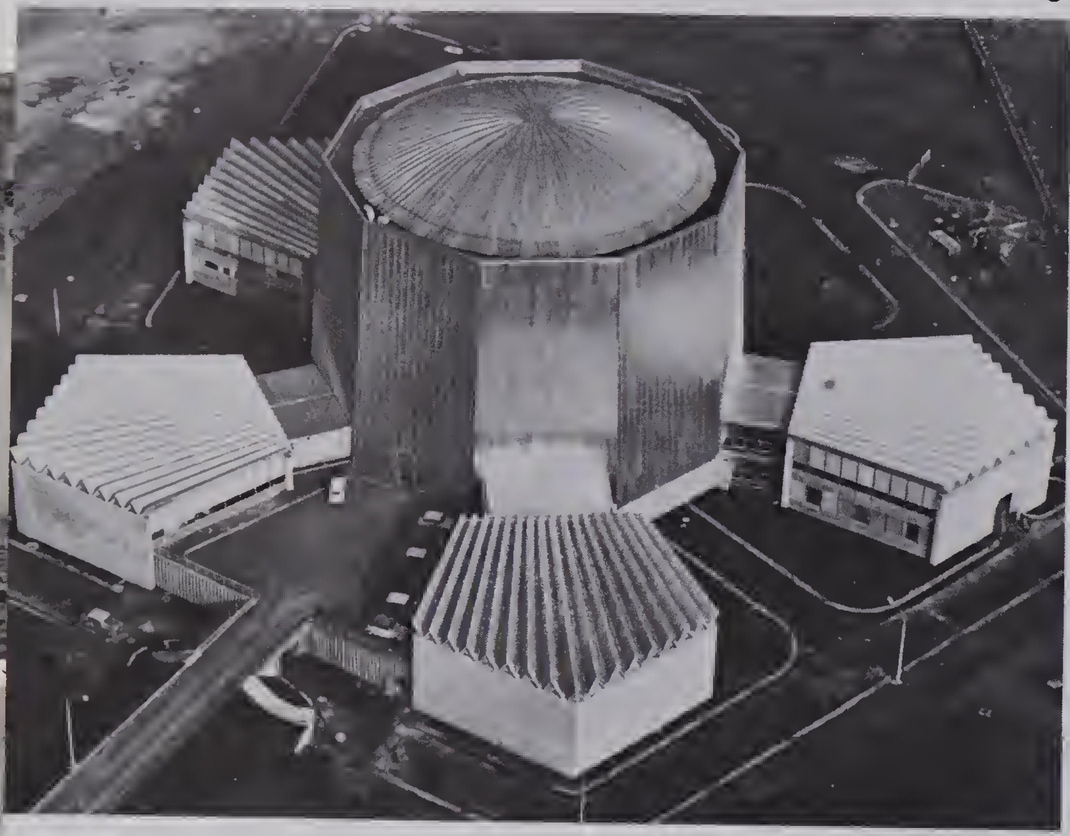
9

The Monorail is another new form of transport whose evolution we are now witnessing. The diagram, **6**, *shows different principles which are now being tried out.* **7**, **8**, *and* **9** *show the applications of these principles. The future shape of the Monorail will depend on which of these is the most efficient.*

1

1. A Comet air liner 2. A nuclear reactor

2



3

In recent years many new shapes have been developed to match new inventions. Nuclear power stations, jet engines, oil refineries, are new shapes, original shapes; they are the starting place for new lines of development. If you look round you a little, you will find many more.

TO SUM UP

The shapes of all living things have a purpose; if the purpose is not fulfilled the shape sooner or later disappears. Man-made objects, too, have a purpose and only those shapes which serve their purpose best are developed. When a new need appears a new shape must be invented to match it.

4

5

EXERCISES

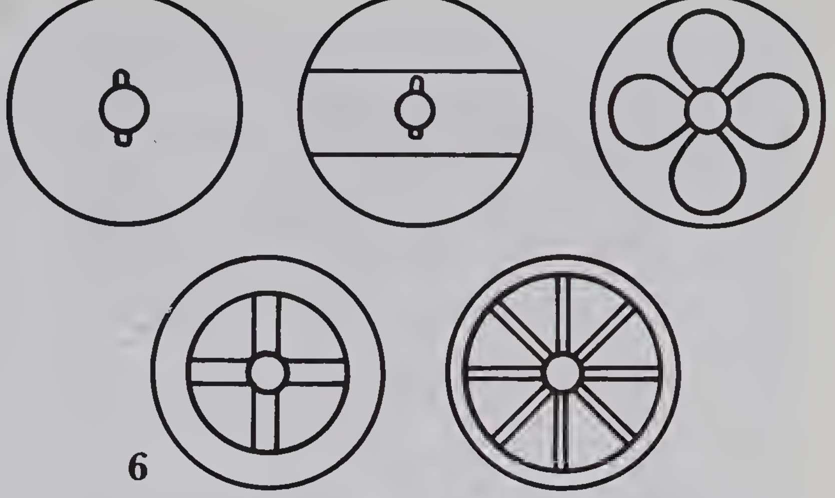
1. Consider these three different subjects: a Roman carving of a cutlery merchant selling his wares, **3**; the development of the wheel, **6**; and the development of the telephone, **7** to **11**. Many of the knives in the Roman carving are very much like the ones we see now; there has been little change. The changes in the wheel are caused by an improvement in efficiency and a change in the materials used. The shape of the telephone is changing because as its efficiency has increased new materials and new methods of manufacture have become available. Look at these pictures carefully and explain why the wheel and telephone shapes have changed so much and why the shape of the knives has changed so little. Can you think of other objects which show comparable development?

2. Picture **12** shows the wooden frame from page 45. Imagine that you have to design a similar structure, for the same purpose, but made of plastic instead of wood. Will you change its shape? Illustrate your answer with simple drawings.

3. You can see that the frame will be efficient only if the forces acting on it are in the same plane as the frame. If forces were to act at right angles to the frame, as shown in diagram **13**, it would not be very efficient. How would you re-design the frame to make it efficient, that is strong, even when it is stressed at right angles?

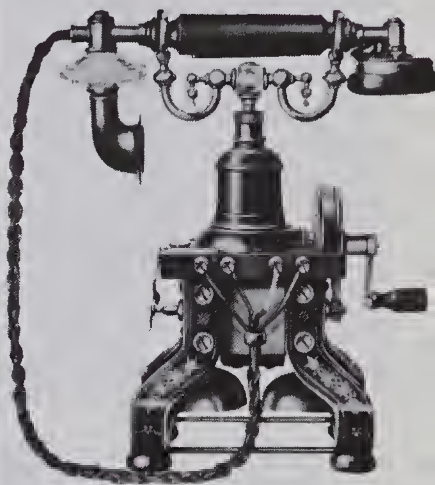
4. Picture **4** shows how the jam jar has changed over the years and picture **5** shows the effect of the latest change. Seven of the latest jars weigh no more than five of the earlier ones. Try and explain how you think this was achieved without loss of strength. Is the latest jar a more efficient shape than the others, and if so in what way?

5. Find and describe other objects which are still in the process of evolution.



6

7 **8**



9 **10**

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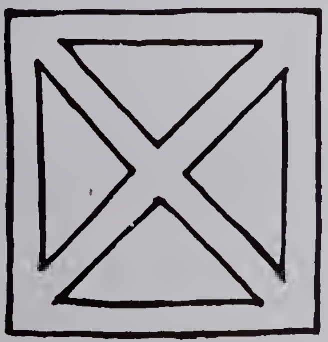

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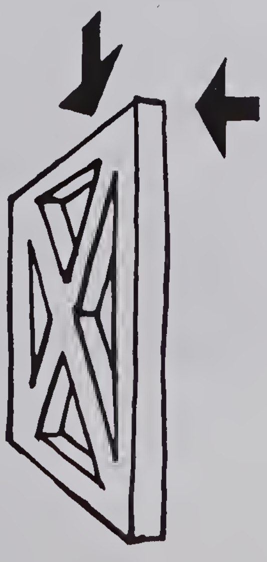

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4

Honest shapes express their function

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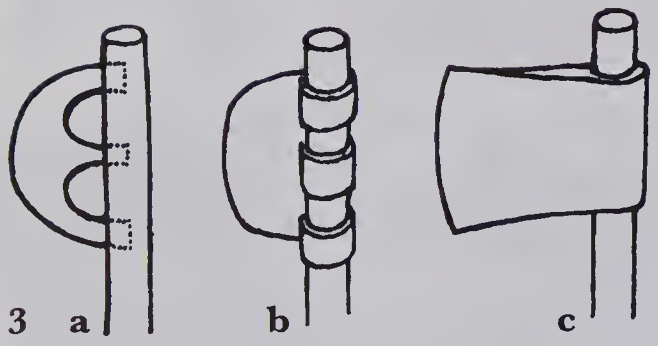
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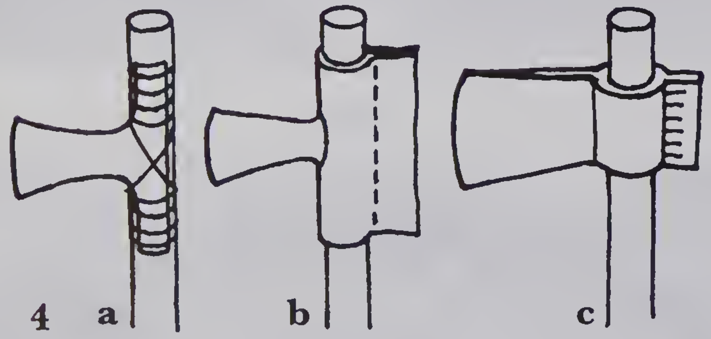
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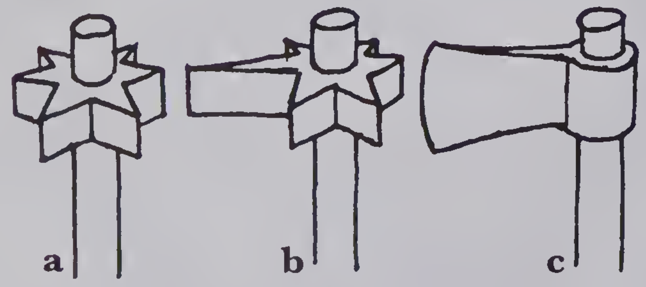
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We have seen how man-made objects, like living things, evolve towards their most efficient shapes. When we consider such a shape in relation to the purpose for which it is designed it is impossible to think of any other shape which will do the same job equally well. The basic shapes of a hammer or a pair of pliers are excellent, well adapted to their purposes, and any change would probably be for the worse. There is an inevitability about them which is like that of natural shapes.

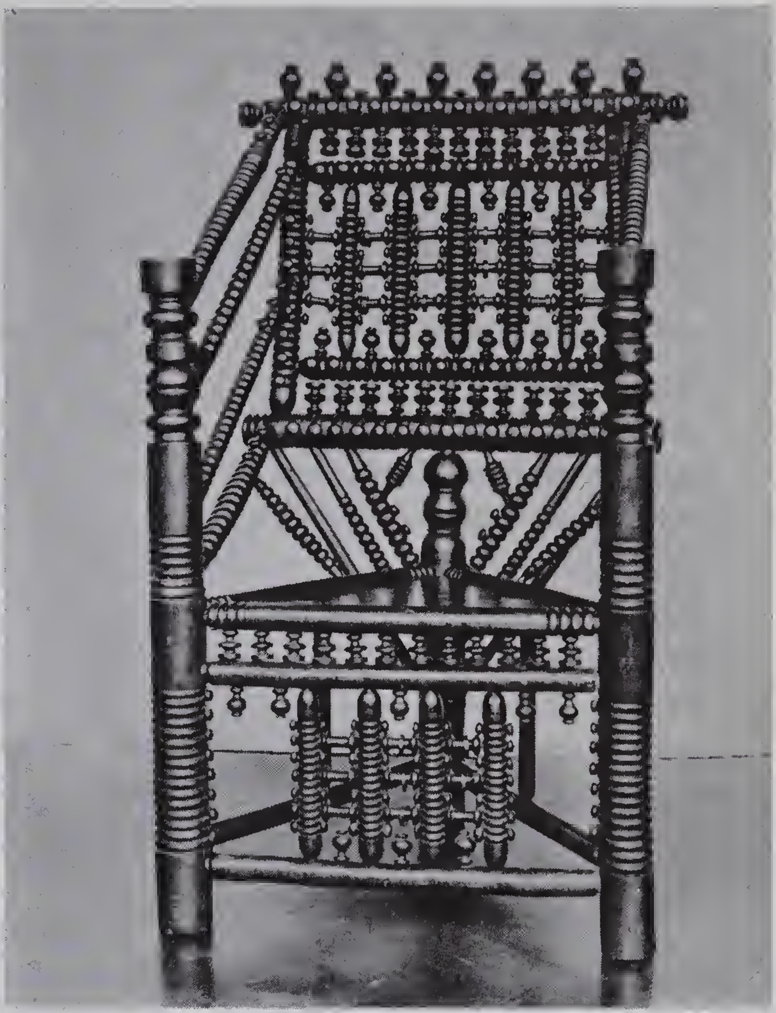
If you go to a museum and look at early tools and weapons you will notice a great similarity between many of them, even if they come from entirely different parts of the world. You will find that a prehistoric arrowhead of the well-known pattern, **1**, from any part of Europe, has much the same shape as an arrowhead from other continents, even from America, **2**, or Australia, with which there was no way of communicating in prehistoric times. It is often said that "form follows function" which means that shapes adapt themselves to whatever purposes they are expected to perform. It follows then that if those purposes are similar, the shapes must also be similar. The development of the axe in different parts of the world is another example of how similar shapes evolve as the result of similar purposes. You can see from the drawings that although **3c**, **4c**, and **5c** started from differently shaped earlier tools their final shapes are remarkably similar. This is rather like solving a mathematical problem in a number of different ways and getting the same answer each time: it proves the correctness of the answer.

There is then, broadly speaking, only one best shape for a given purpose so long as the material and the method remain the same. But as soon as either the material, or the method of working it, change, the shape will also change, in order to remain efficient for the purpose. It should also follow that if there is no change in material or method there will be no change in the shape of the object, once the most efficient shape has been found.

We all know, however, that this is not strictly true. If it were we should be surrounded by shapes as perfect as those of nature, like flowers, birds, and fishes. But in most streets of our cities and in most of our homes we can find many things which do not seem to have the perfection of the efficient shapes we have been discussing. For instance, look at these two chairs. The first one, **6**, looks as though the man who made it rather enjoyed using a lathe and in fact did not know when it was time to stop. Working with the lathe must have been great fun while it lasted, but do you think that a craftsman who respects his materials could produce a chair like this? Do you think the material was used wisely and with sympathy? Do you think this is a comfortable and pleasant chair? The second chair, **7**, was carved to look as though it had been made from the branches of a tree which were tied together at the top to give it an arched back. Do you think that the maker of this chair used his skill wisely, or that he had imagination and feeling for his material? Did he produce a good chair?

These two chairs show what happens when we lose our feeling for our materials and become insensitive to them. In chair **6** this lack of understanding is plain for all to see. Not only is the chair unnecessarily complicated, but it is by no means clear, to a casual observer, that it *is* a chair. The maker of this chair seems to have been quite indifferent to the material he was using and to the purpose of a chair. The same can be said of the maker of chair **7** but here his indifference is concealed by imitation. The person who made this chair had no more imagination than the one who made chair **6** but he managed to disguise this lack by hiding behind an imitation of something else. Imitation is in most cases the language of a bad craftsman or designer, who can either produce a thoroughly bad shape, like chair **6**, or can try to cover up his incapacity by imitating something else. These two chairs are extreme examples of bad design, but the false principles which governed them also cause many of the bad shapes which we see on all sides.

We have seen that as each new material is introduced, traditional shapes belonging to other materials are at first imitated, before the true shapes for the new material begin to develop. This is not surprising, because the new shapes must be related to the character of the new material, and to the method of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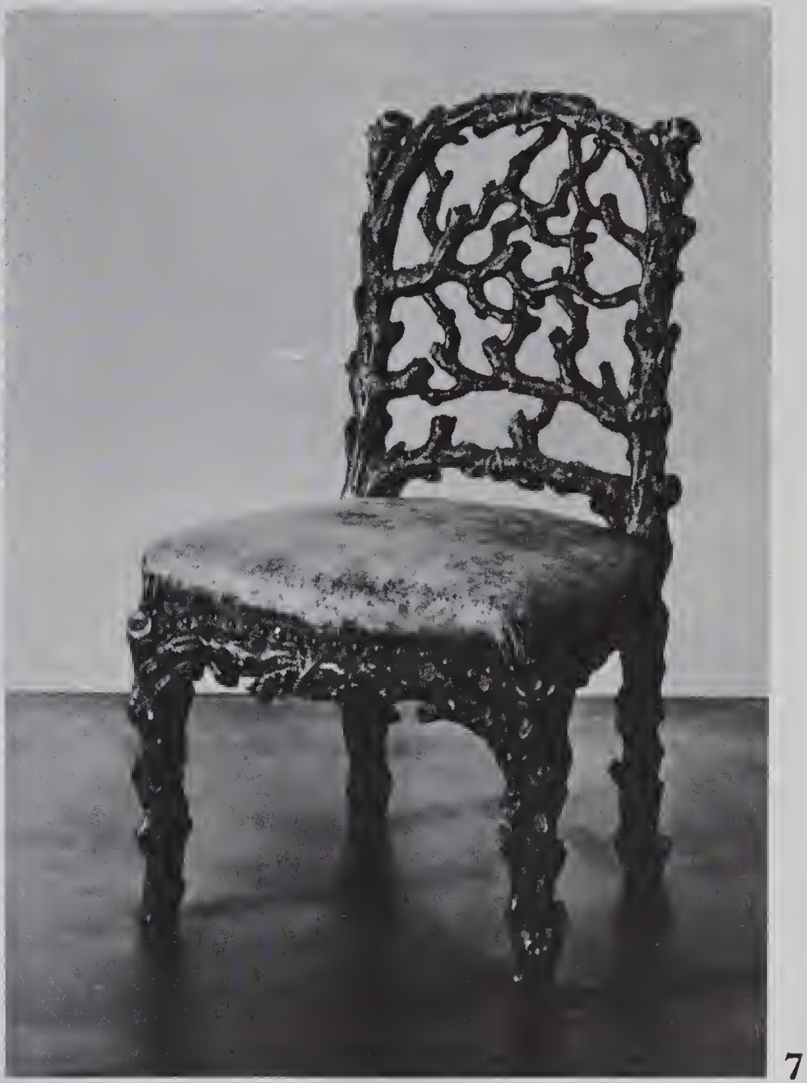
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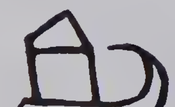
working it, and nobody knows much about these to begin with.

There is also something else to be considered. Human beings resist change and like to go on in the same way. When people go to live in a different part of the world, one of the things they try to do is to make their new home as much like the old as possible. That is why there are towns outside Great Britain with such names as Boston and Canterbury and Perth. When new inventions threaten to change our way of life, we resist them and they often have to be modified so that the shock which we suffer is lessened. When wheels were first put on vehicles, the runners which they replaced were still kept as part of the vehicle, even though they were now quite useless, **1** and **2**. As a result the new wheeled vehicles looked rather like the old sledge-like things which everybody was used to. For the same reason early pottery vessels often followed the forms and patterns of the materials which preceded them. **3** imitates leather and **4** basketwork. Early gas cookers had a pattern of tiles painted on them to remind people of the old wood stoves. History can supply many more examples like these.

There is nothing bad in this kind of imitation. It is only temporary and is part of the evolution of a shape. But the imitation of twigs on the chair on page 67 is outside these evolutionary changes. It was a deliberate action on the part of the maker, who had no regard for the true nature and purpose of the chair. We may ask why bad shapes, like the chair, should be made at all when, with no more effort, good shapes can be produced.



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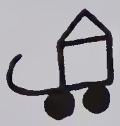

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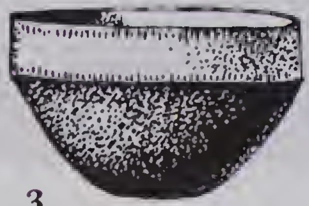

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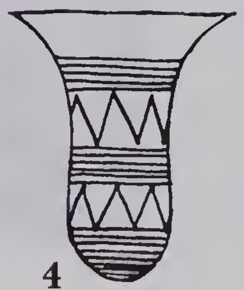

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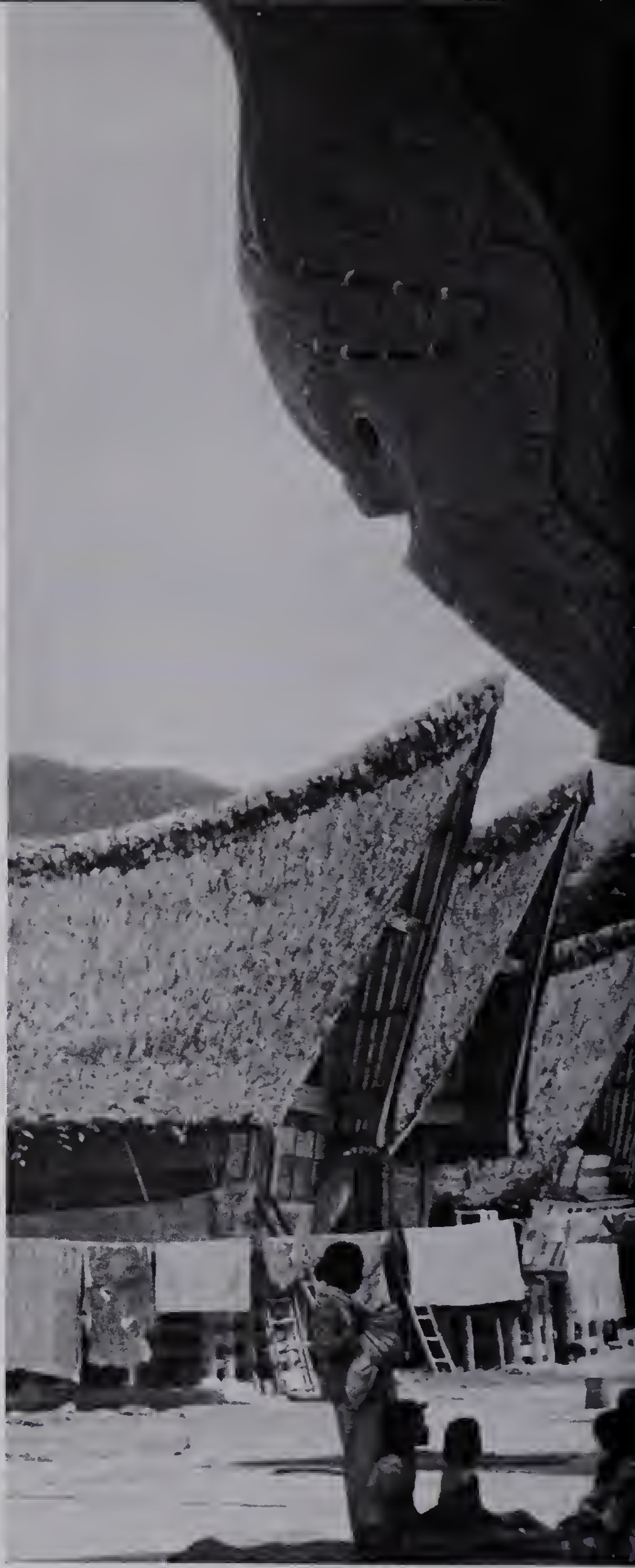

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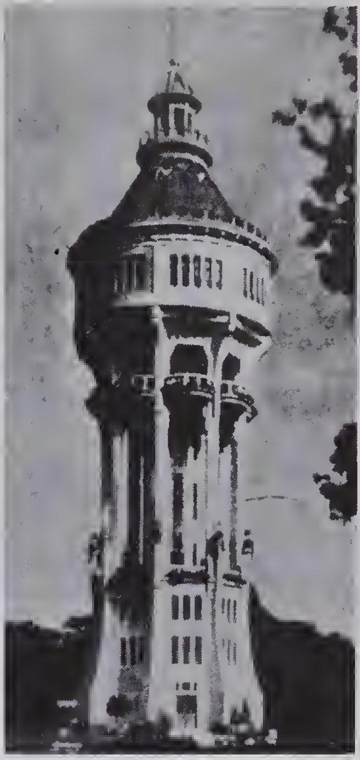
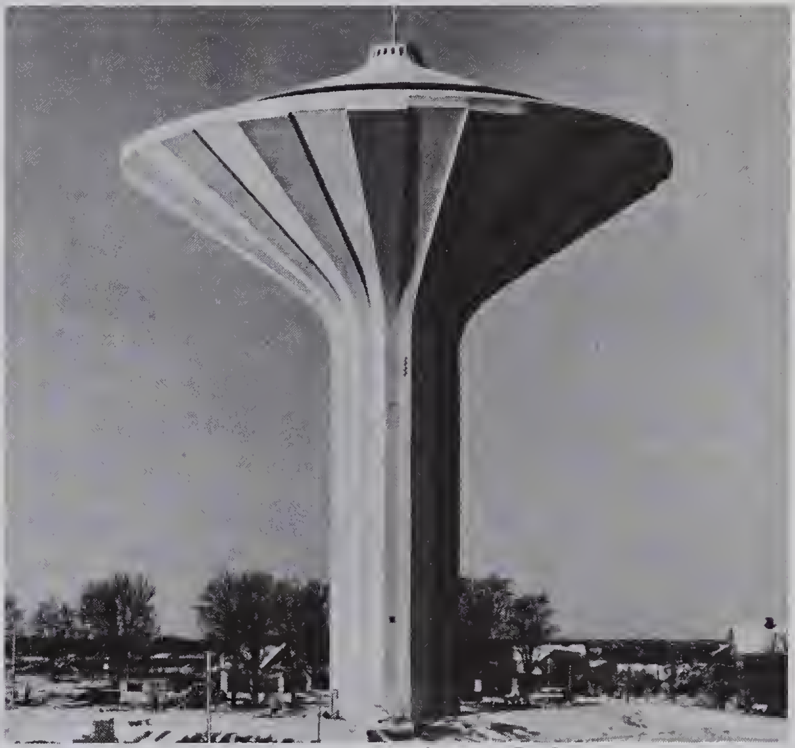
When these Indonesian villagers first used corrugated iron as a roofing material, **6**, *in place of the traditional bamboo and grass,* **5**, *they continued to build their houses in the same shapes as before, although the steep pitch and the curved beam were no longer a necessary part of the construction.*

6

7



The water tower built of reinforced concrete in 1906, **7**, *makes use of forms derived from older styles of building, but modern architects have learnt to use this material in a more efficient way. The form of the Swedish water tower,* **8**, **9**, *uses less material and shows its function quite clearly. The curvature is calculated to give the greatest strength. Like the maker of the first bronze tools, the designer of the early water tower used the shapes with which he was familiar.*



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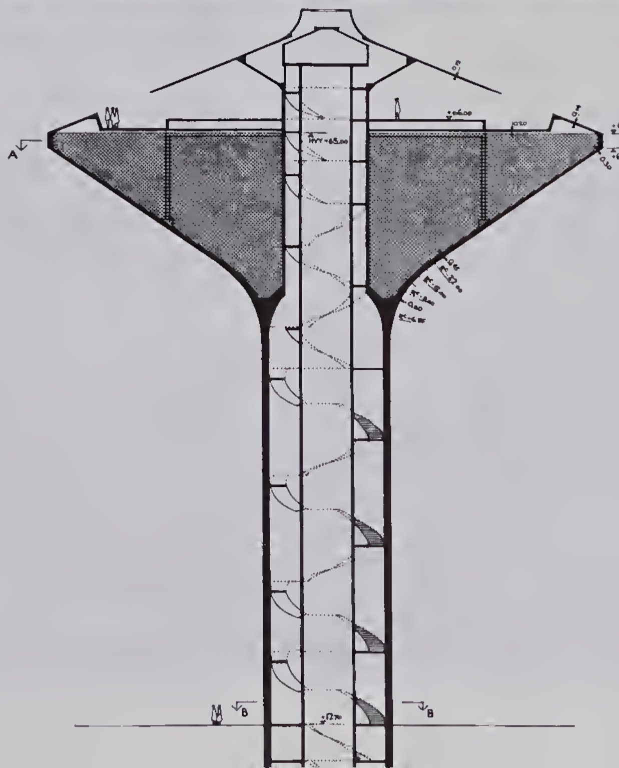


1

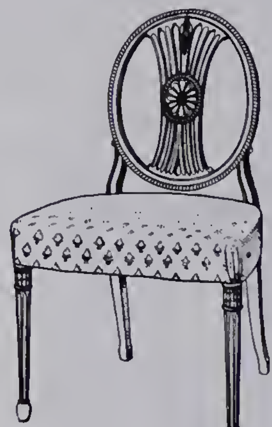
2

We have already discussed, in Part One, a number of reasons which have led to a lowering of standards of craftsmanship since the Industrial Revolution. One important reason is the ease and speed of manufacture which modern machines make possible. But there are other reasons which have something to do with the way we live.

Long ago every man made his own tools, wove his own cloth, built his own house. In the process he gained a great deal of experience of different materials and learned to know what are good and what are bad shapes. Gradually, however, manufacture was increasingly left to specialists who were skilled in one particular craft.

In picture **1** you can see what the house of a medieval specialist craftsman looked like. His workshop was in the back part of the shop, where he himself attended to customers. More often than not, he would make an article specially for a customer; he would advise him and give any information required. The customer could rely on the craftsman's knowledge and take his advice, for he was an expert about the goods he sold.

Picture **2** shows a shop of the eighteenth century. The



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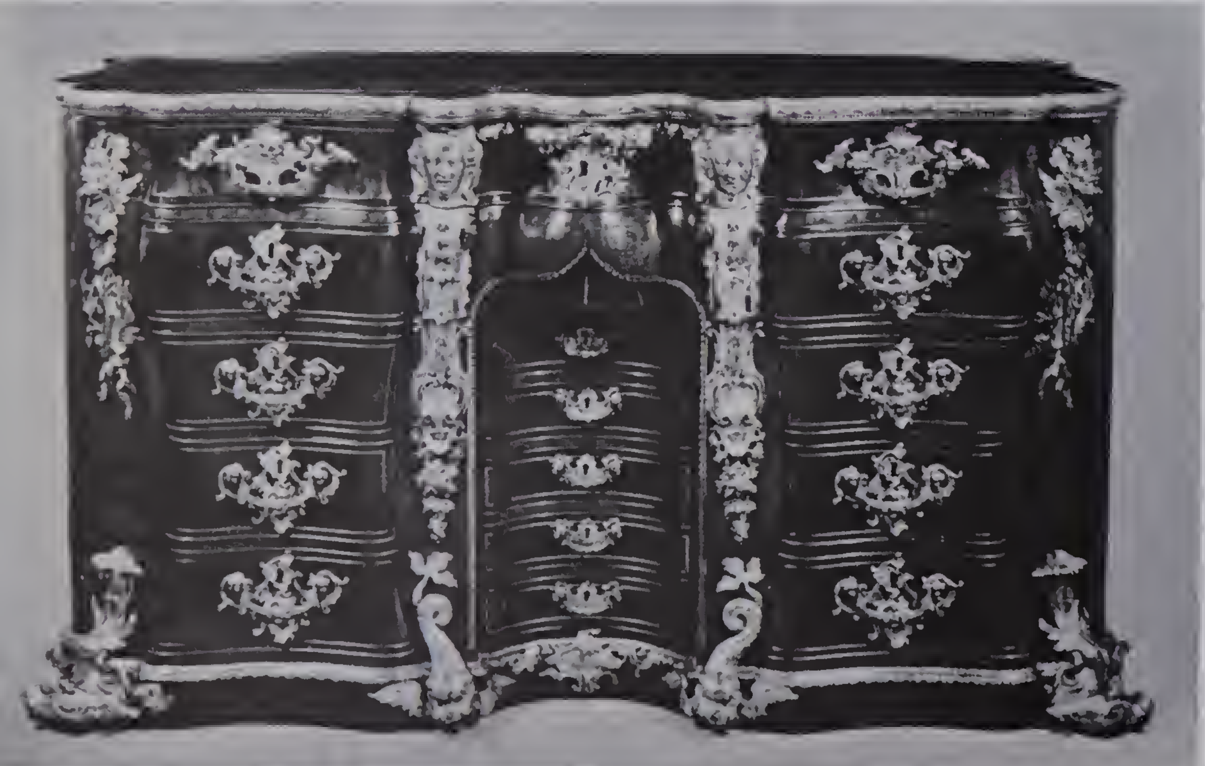
This chair, designed by Adam in the 18th century, has a great deal of elegance, but it is not really a chair shape; a chair-maker would probably never have thought of it. The oval is an arbitrary form and has nothing to do with the material or purpose of the chair. The designer was more concerned with creating an effect than making a good chair and only a high degree of craftsmanship could have made this chair possible. The thought behind this chair does not derive from its material or purpose: it is the beginning of a downwar trend in design. On what count would you criticise this bureau, **4***?*



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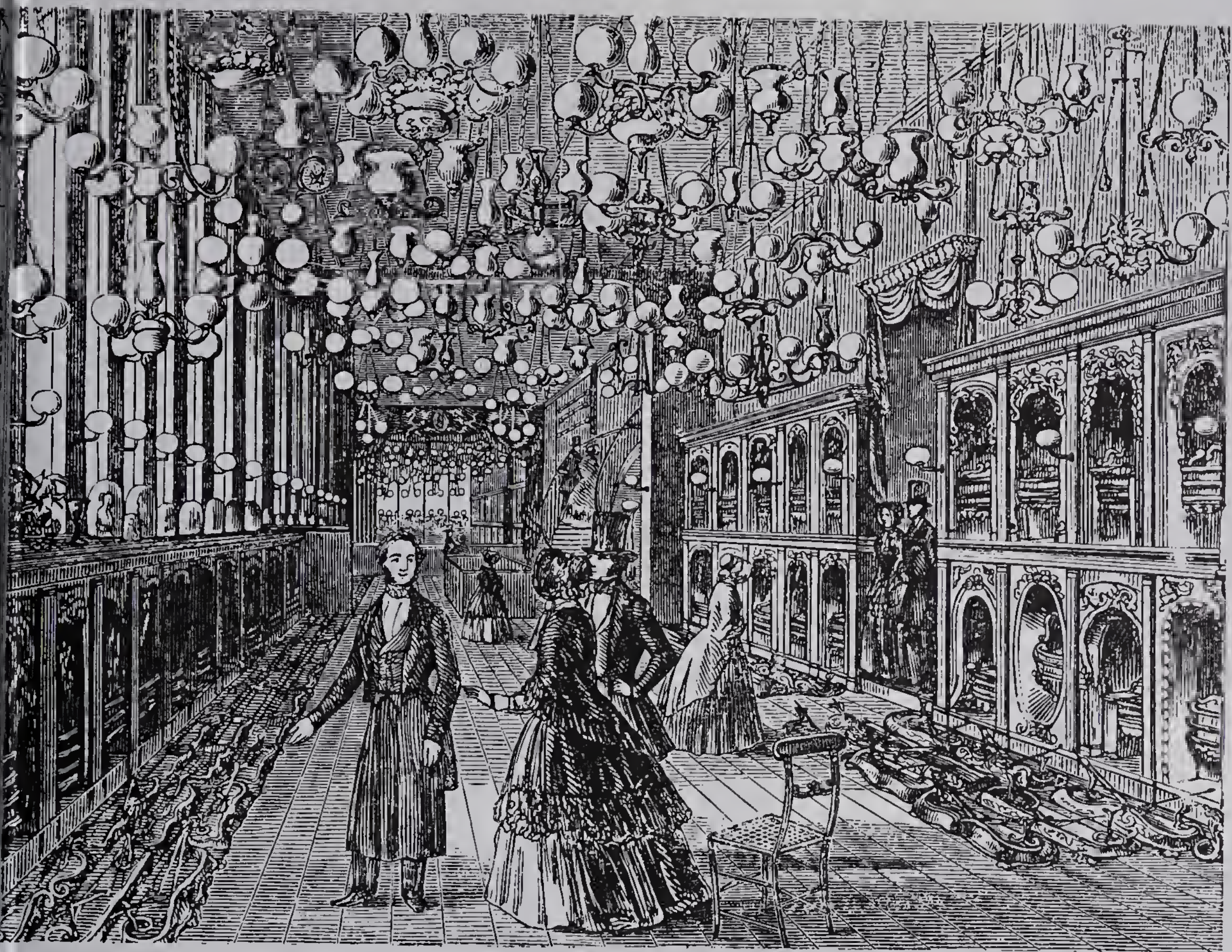

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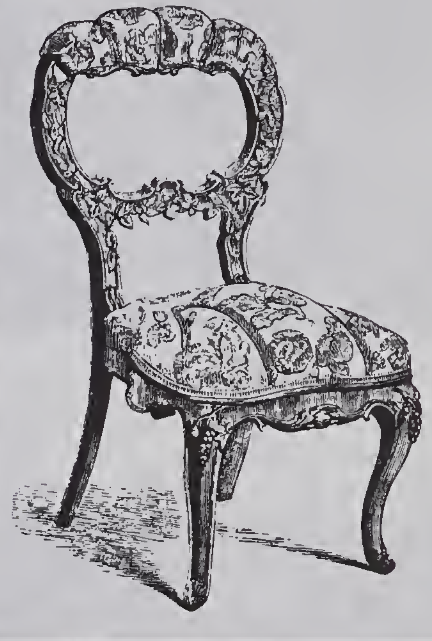
Pictures **1**, **2**, **5**, *and* **7** *show part of the story of the deterioration of design. The principles of* **3** *in less skilled hands gave rise to monstrosities like* **6**. *Even though the shops themselves have grown more attractive,* **7**, *do the customers understand design as they used to?*



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person serving behind the counter was no longer a craftsman, but a shopkeeper. He did not make the goods he sold and therefore did not know as much about them as the medieval craftsman. His customers, who were no longer in immediate contact with the manufacturing process, as they had been in the days of the craftsman-shopkeeper, were less aware of the connection between materials and shape. They were beginning to be more concerned with fashion. As a result the standard of design in most ordinary useful objects began to deteriorate.

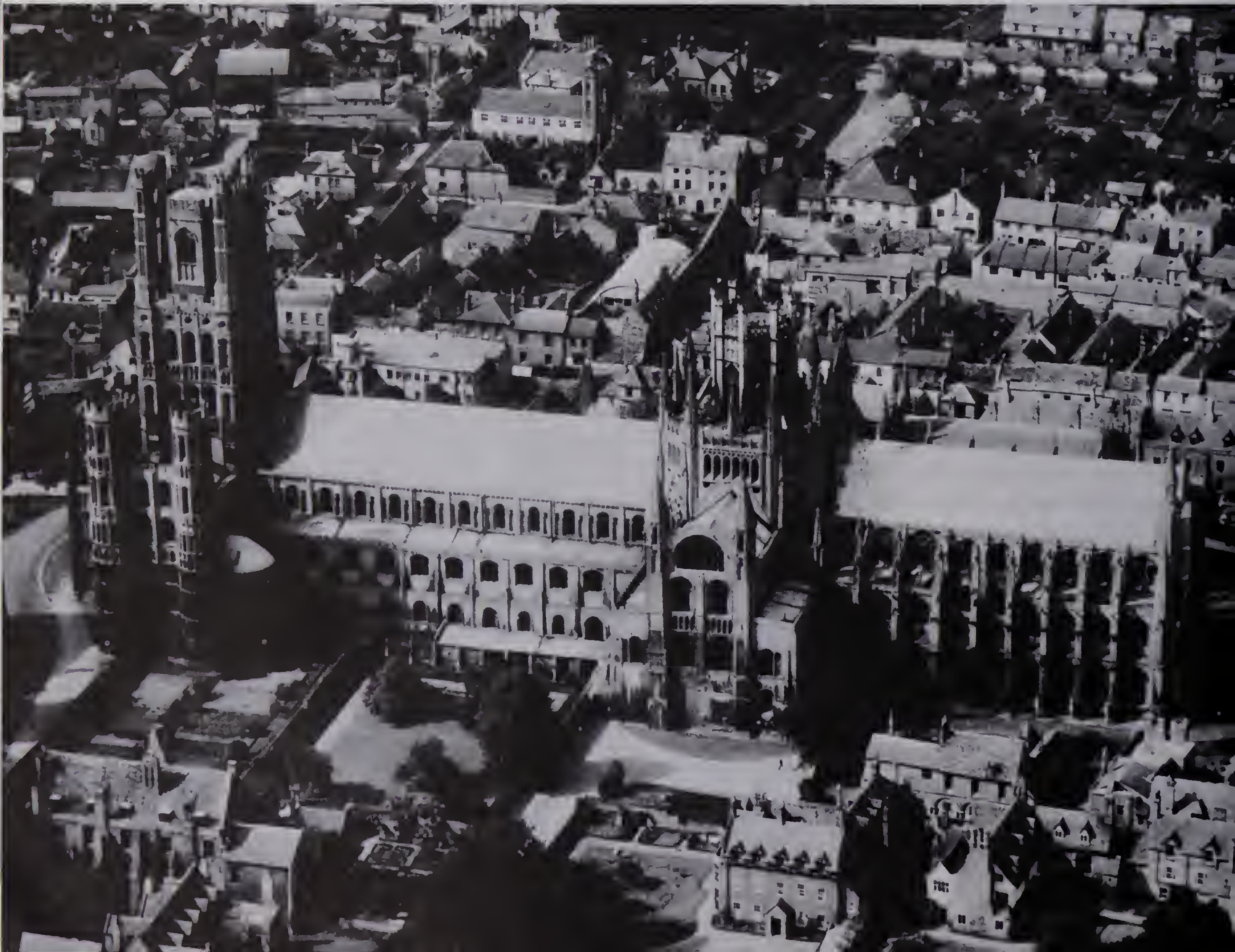
In a modern multiple store the shop assistants have only the vaguest knowledge of what they are selling; in self-service shops and supermarkets there are no shop assistants at all, and in future we can expect to have more and more shops of this kind. The separation of the consumer from the maker of the goods he buys, a movement begun in the eighteenth century, is now complete. Goods are produced by increasingly complicated processes in factories which ordinary people never visit. We are unaware of how most articles are made and do not know how to judge them properly.

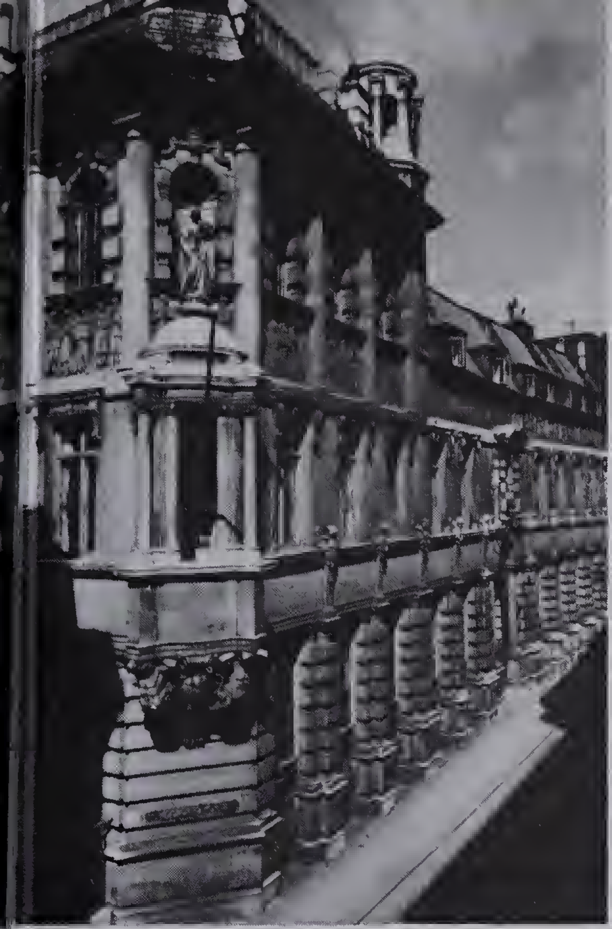
7

1. *The modern and the older buildings in this picture look quite happy side by side; both are honest expressions of their times.*

Until the eighteenth century craftsmen and builders made changes in methods and materials whenever these seemed likely to increase efficiency. They did not continue to imitate earlier styles, once they had discovered a new and more efficient method. Even when they added to existing buildings, they did not copy the style of the original builders but built in the way they themselves found to be best. Churches, for example, were added to over hundreds of years, and as the methods of building changed so did the style of the additions. We can tell to within a few years when each part of a church like this, **2**, was built because of the differences in style. These differences in such a building are not at all disturbing. The honesty of purpose common to the various builders is reflected in the unity of the building.

2

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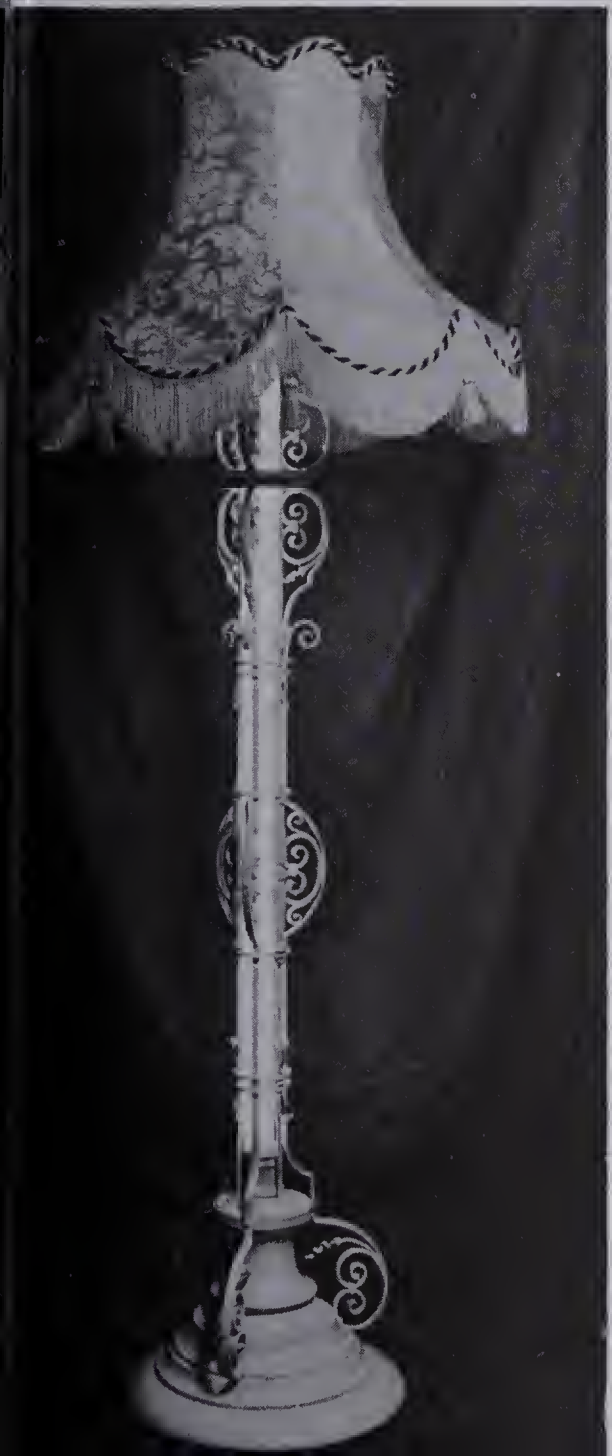
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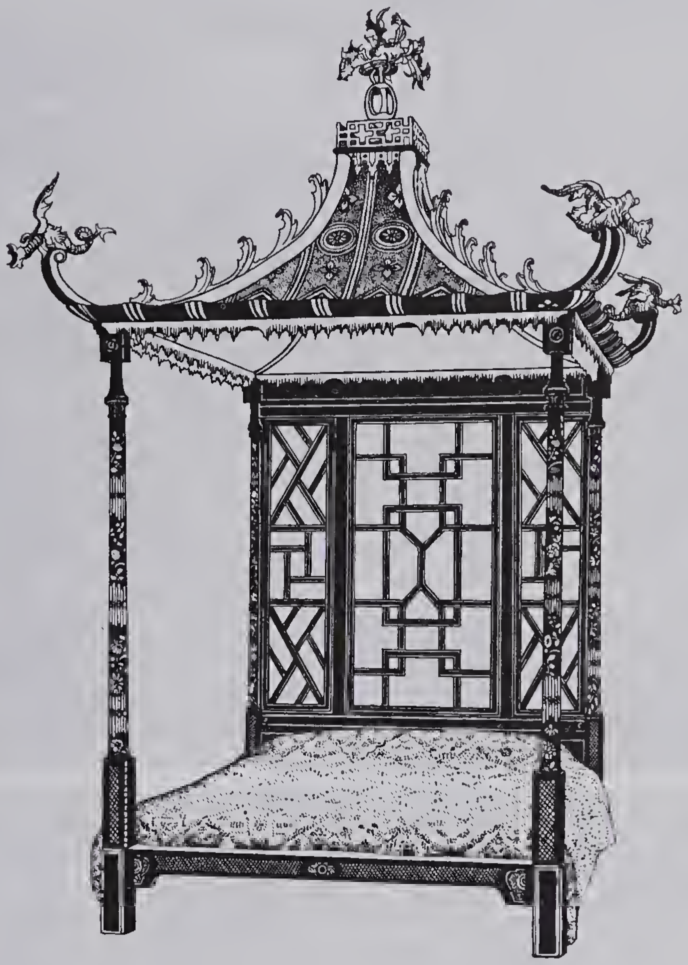
In the eighteenth century people started to look at things in a different way. Many people travelled abroad. They returned with powerful impressions of buildings in other countries and brought back works of art to add to their collections. This influenced their taste and as a consequence houses, furniture, fabrics and many articles were made in a foreign style, an imitation of what had been seen abroad. The best method was no longer a designer's first consideration, and imitation for the sake of appearance was now uppermost in his mind.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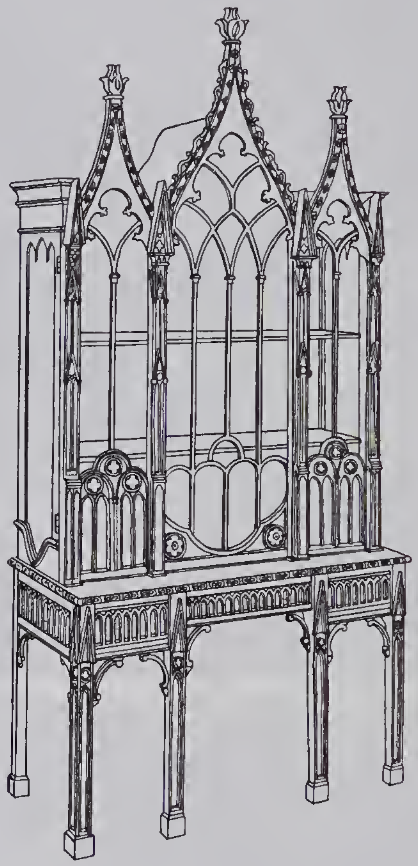
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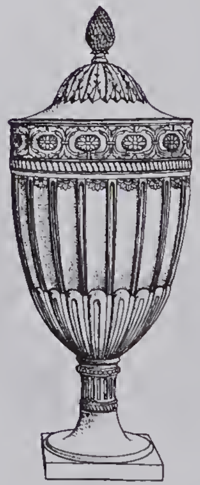
The "Chinese" bed, **4**, *the "Gothic" bookcase,* **5**, *and the "Greek" urn,* **6**, *are eighteenth century imitations which do not make sense. The table lamp,* **7**, *is an imitation of our own day. You can see that it attempts to re-create a feeling of the past. The building,* **3**, *erected at the end of the nineteenth century, does likewise. Do you think that these five objects are easy to use? Does the design of each increase its usefulness? Does form follow function?*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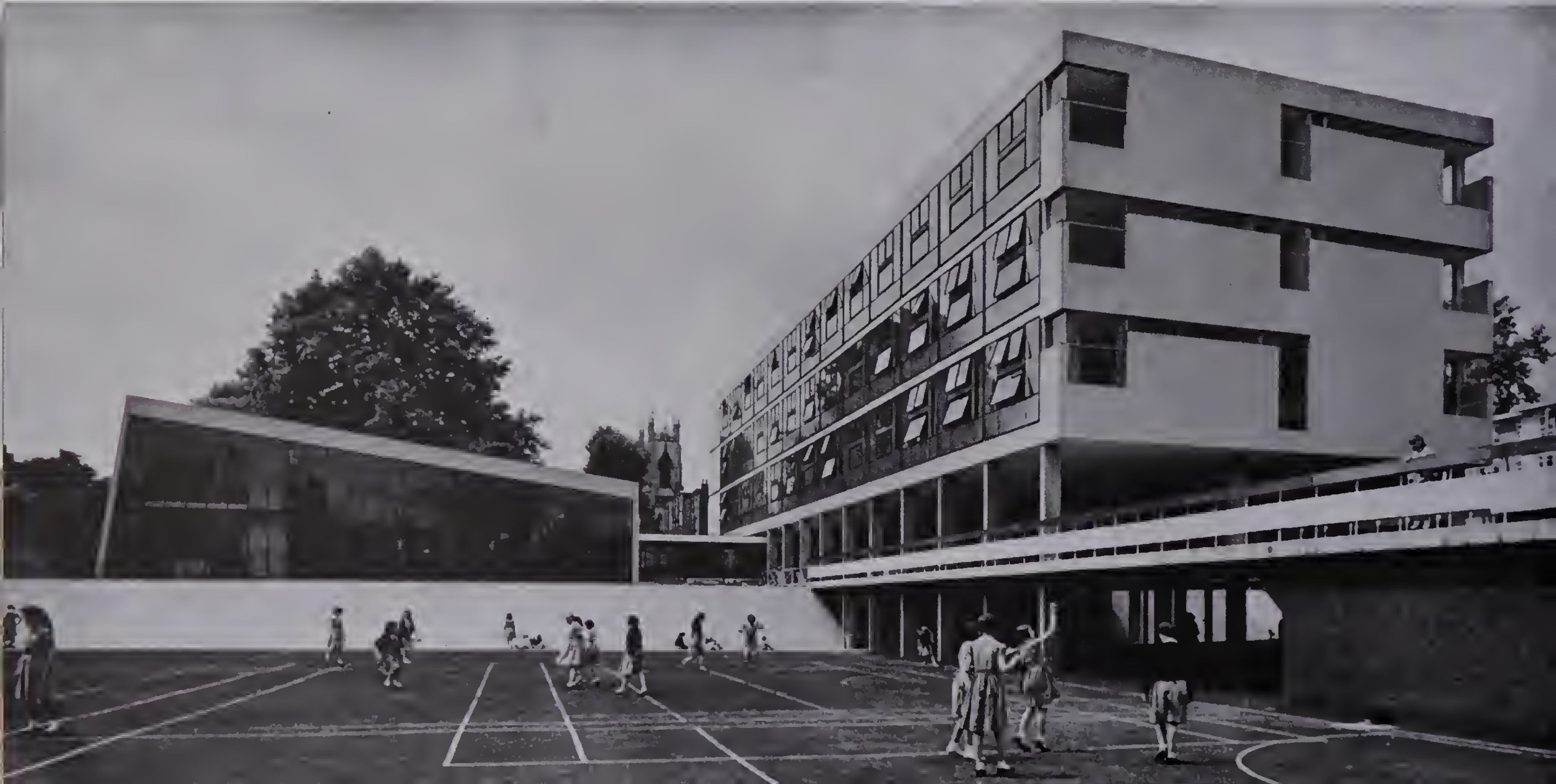

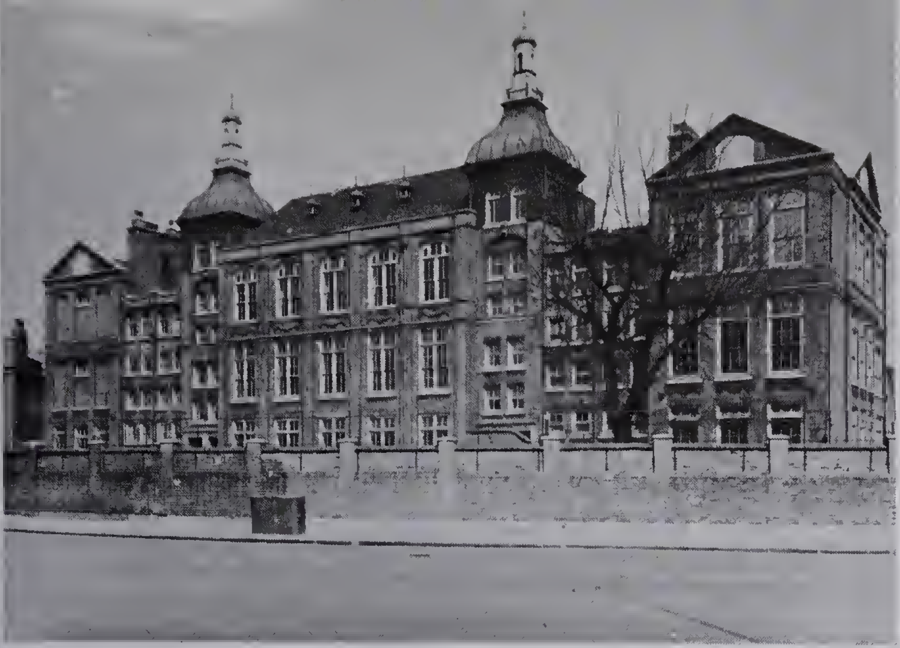

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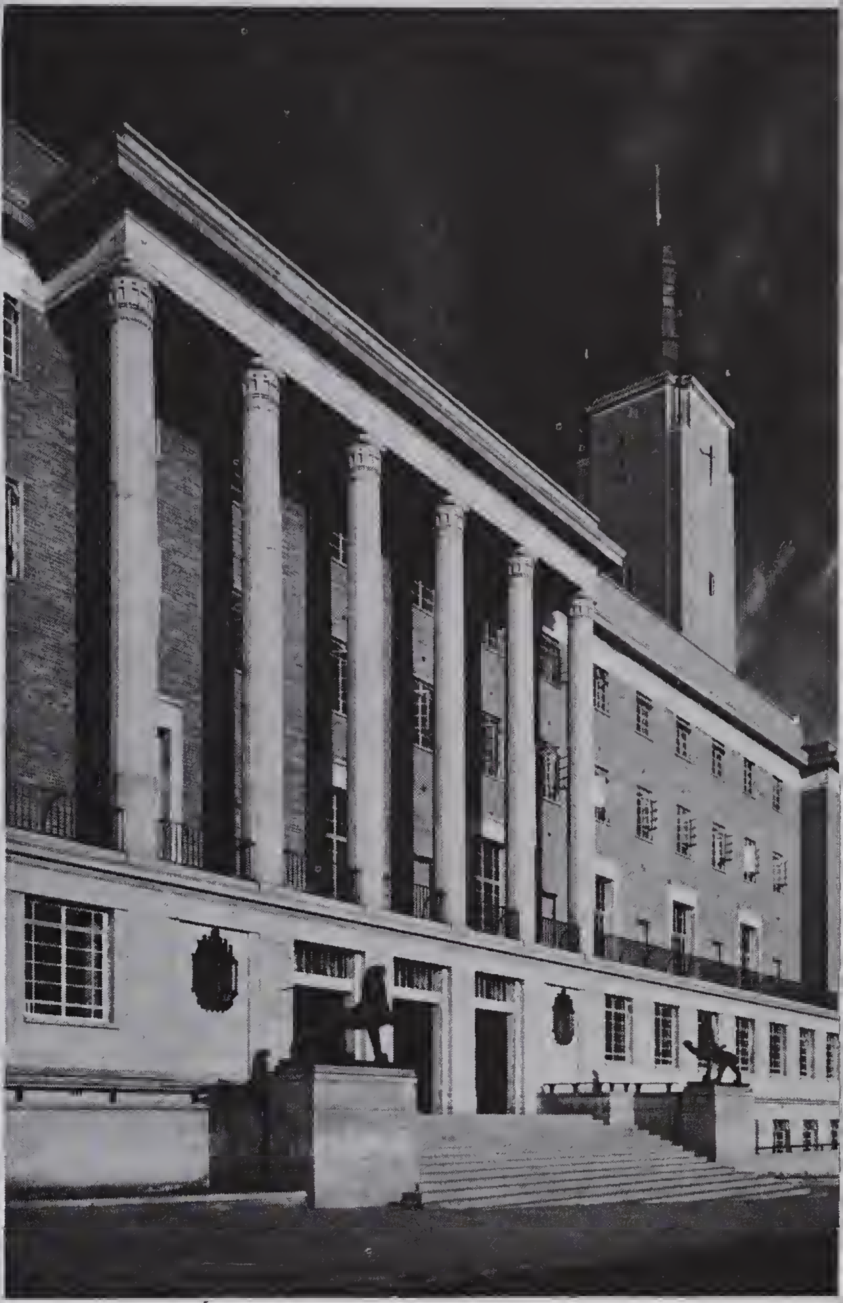

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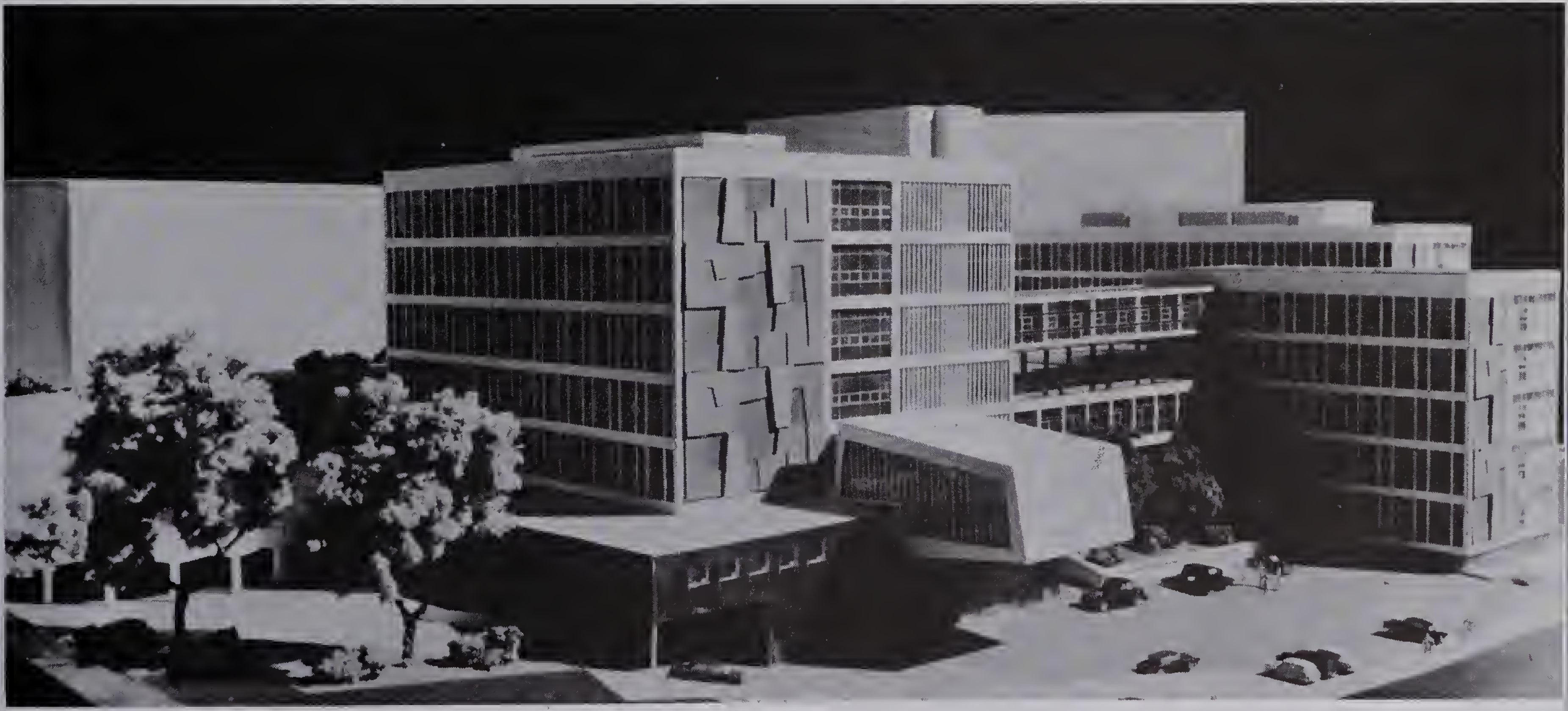
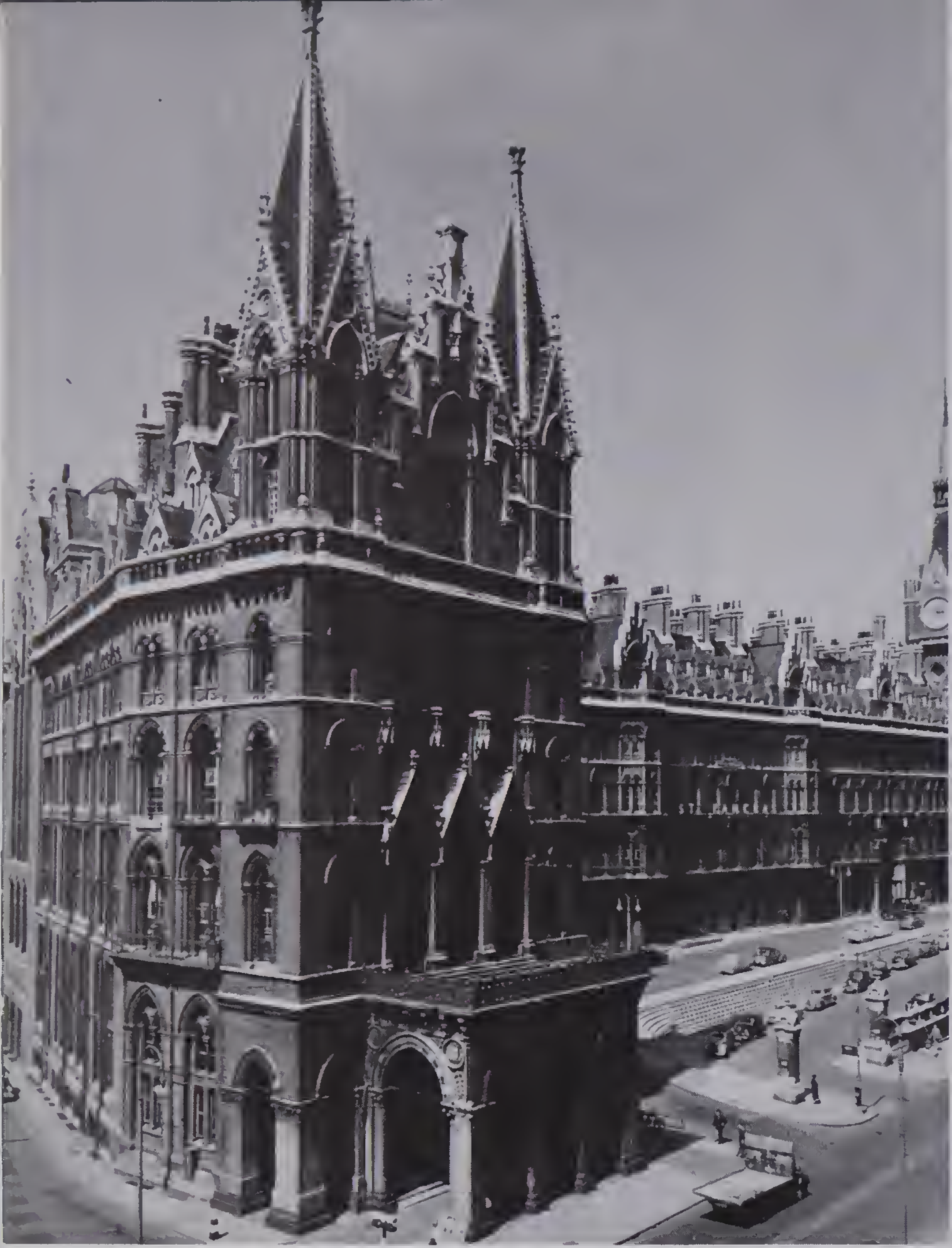
The first concern of the designer of this modern school building, **1**, **2**, *was the efficient working of the school. The stage at one end of the assembly hall required greater height than the rest of the hall, for example, and this requirement dictated its shape, which makes a pleasant contrast to the squareness of the rest of the building. The fact that the main teaching block is on stilts carries with it the advantage that there is a play area under cover, for use in bad weather. The school building in picture* **3** *is an imitation of past styles of architecture, and the requirements of the school had to be fitted into this symmetrical plan; they did not dictate it.*

Norwich City Hall, **4**, *is another example of imitative building. The columns are useless, and only make the rooms behind them darker. Picture* **5** *shows a model of buildings proposed for Bristol University, in which the lecture theatre with its sloping floor can be quickly recognised. Many modern buildings reveal their function from the outside, because their shape is governed by their purpose. They are pleasant to work in and to look at.*

5



Pictures **1** *and* **2** *show how St. Pancras Station in London looks from the outside and the inside. It is strange to think that in 1868, when the building was begun, people thought it necessary to hide the magnificent mathematical vault behind an artificial front, imitating a medieval building. Why should a railway station look like a distorted cathedral? The modern railway station,* **3**, *is of course very much smaller, but it makes no secret of its purpose; the towers are not for decoration; they contain goods lifts.*



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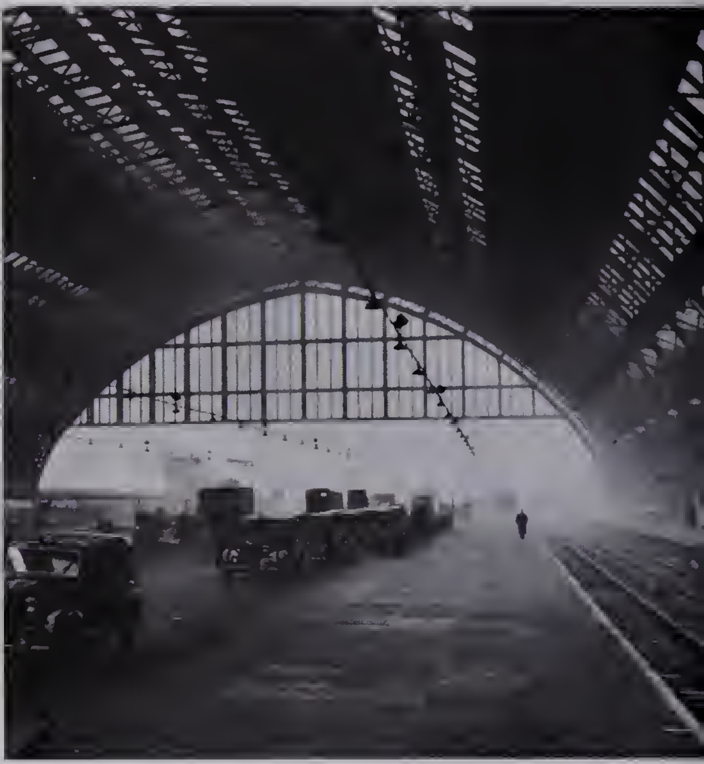

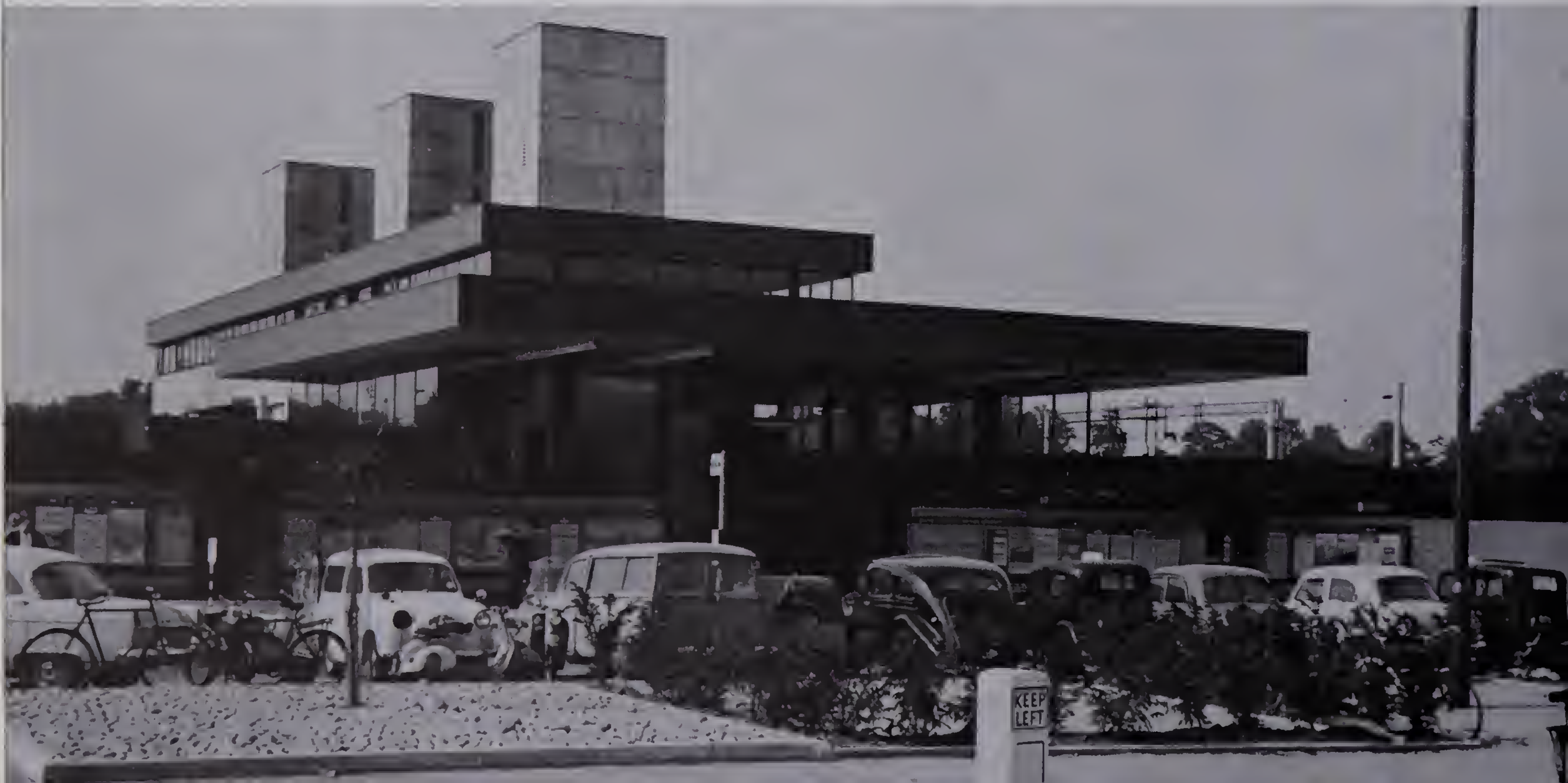

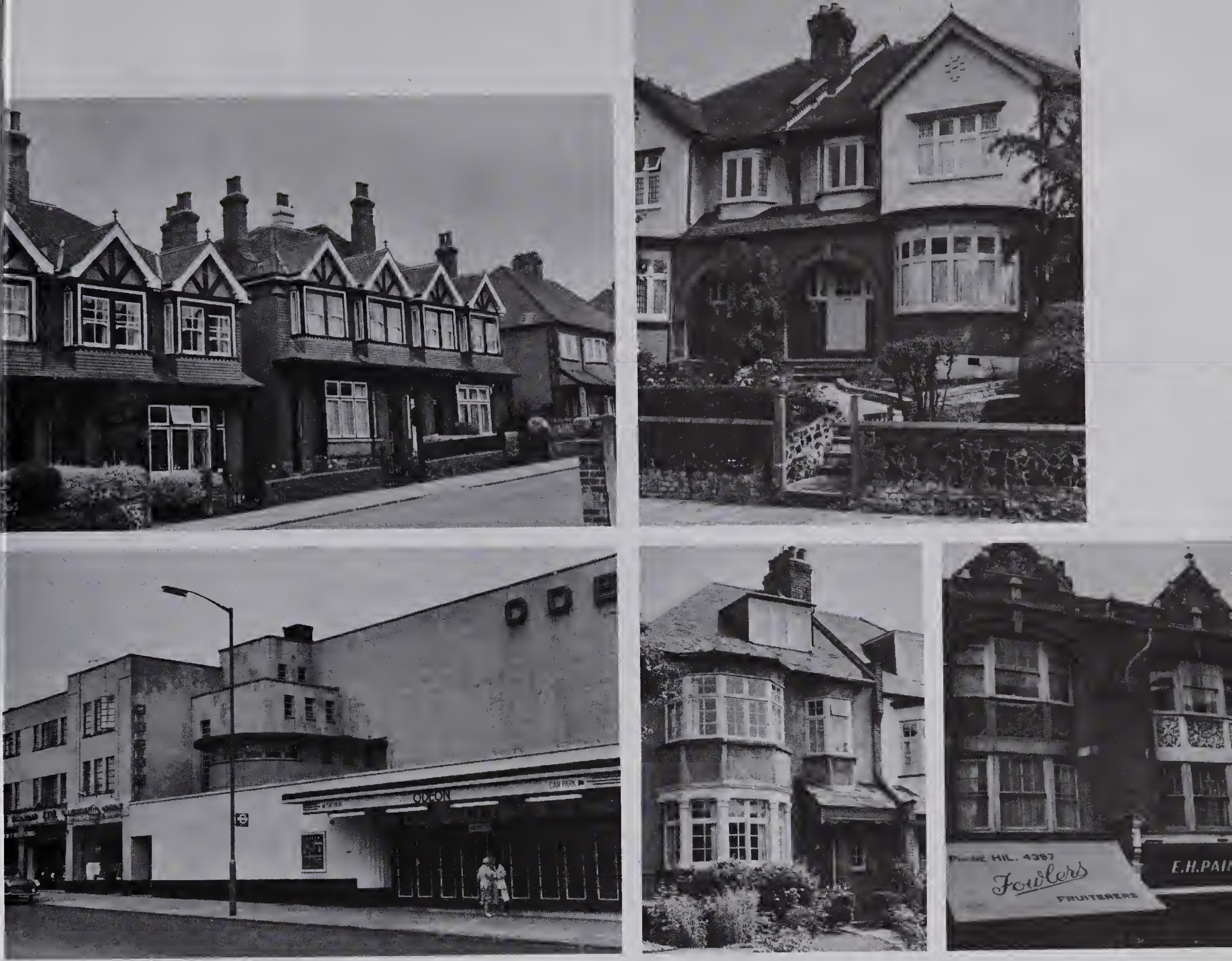

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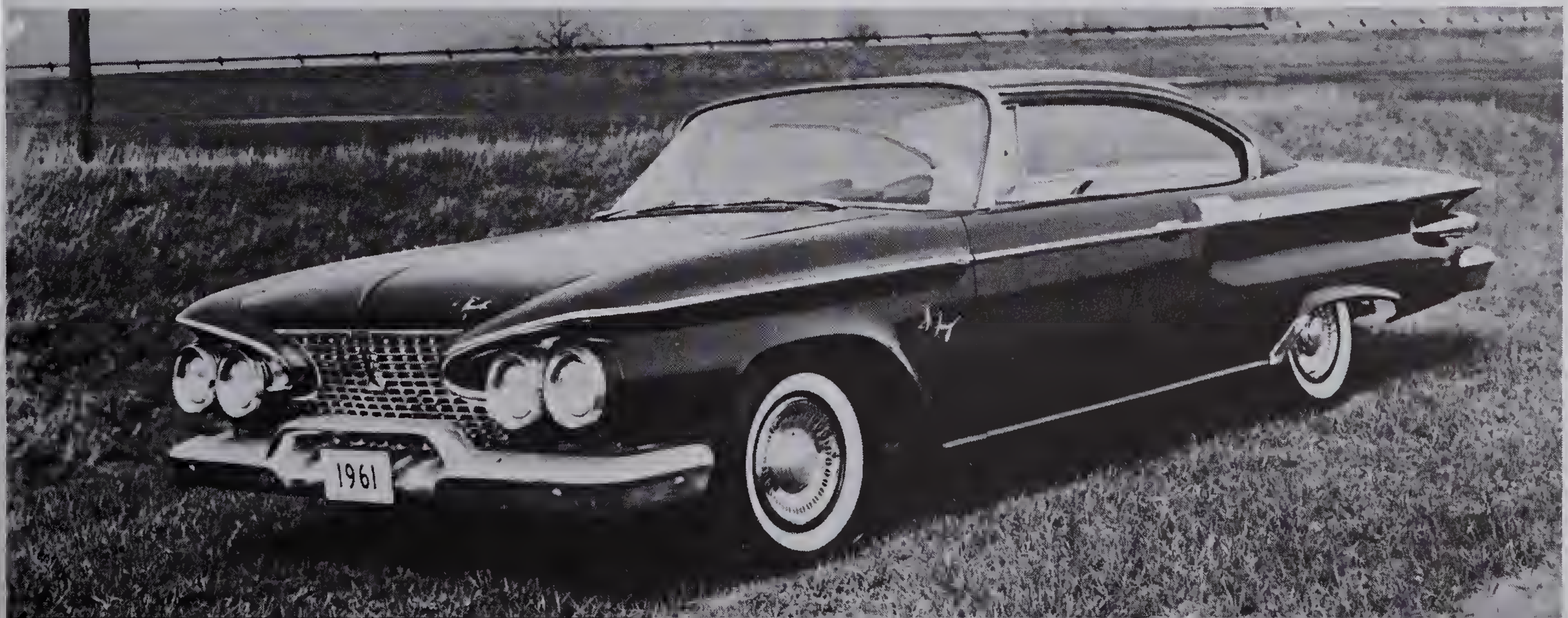
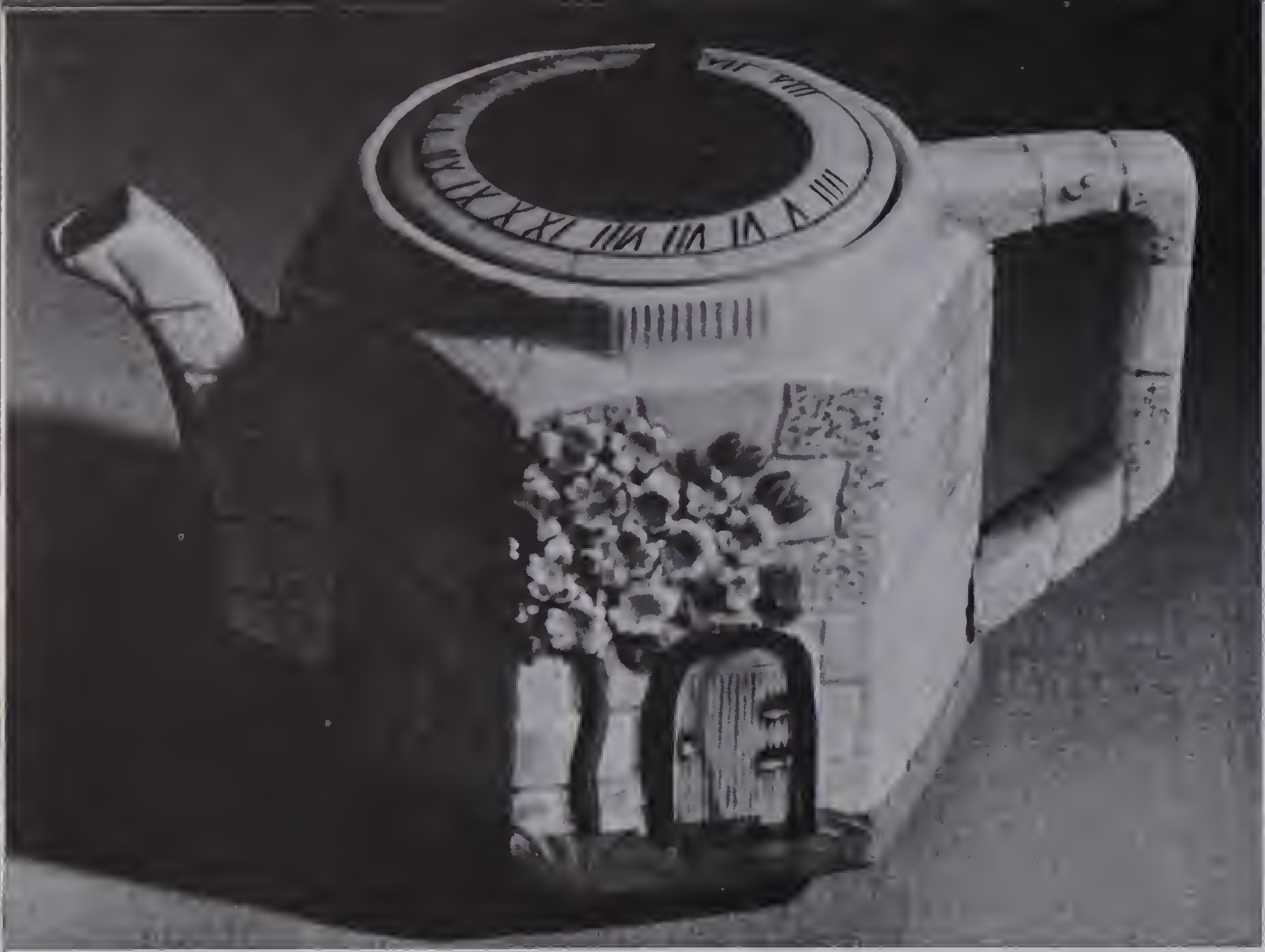
These houses, **4**, *are typical of many suburbs. They show the marks of the bad designer in the same way as the chairs on page 67. Some are in shapes which are non-functional and useless, while others use imitations to hide the builder's inability to produce a good design.*
Why is the motor car, **5**, *built in this particularly inept shape, heightened by chromium ornaments? Is the rear end meant to remind one of a space craft?*

5





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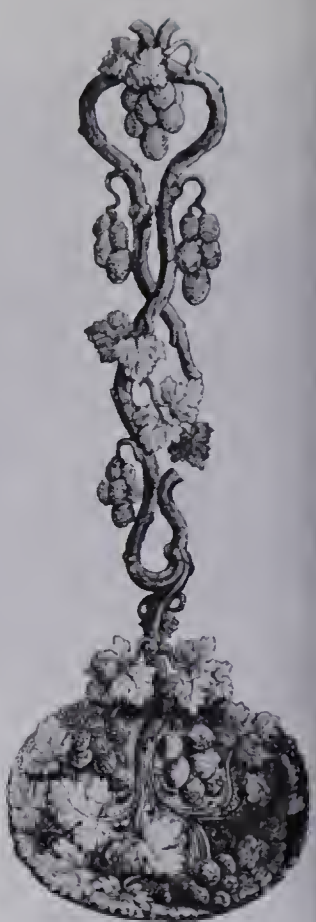

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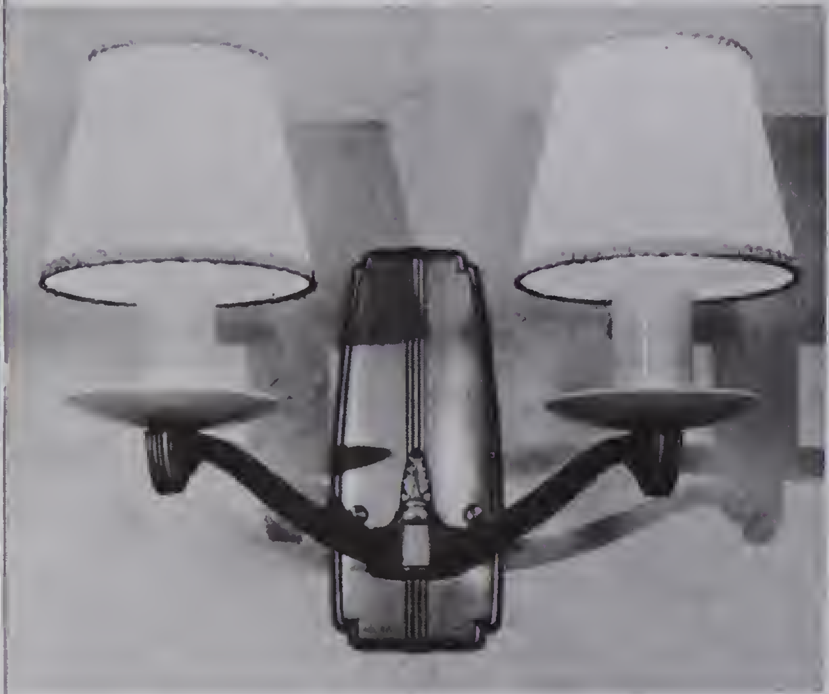

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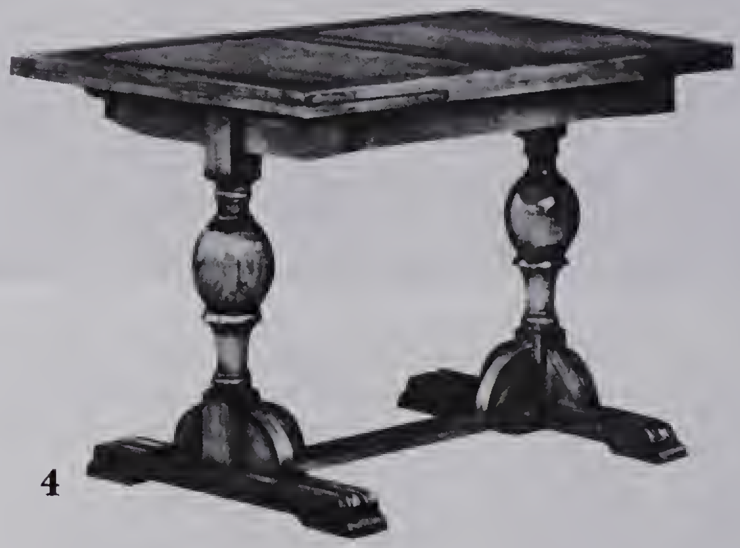

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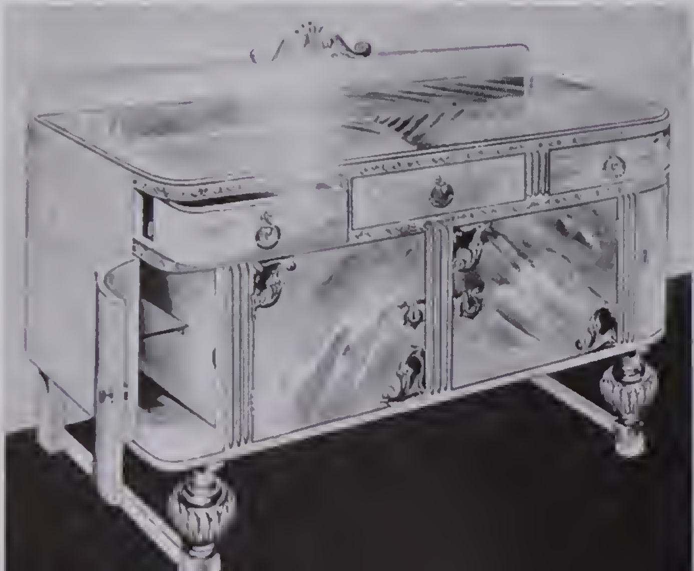

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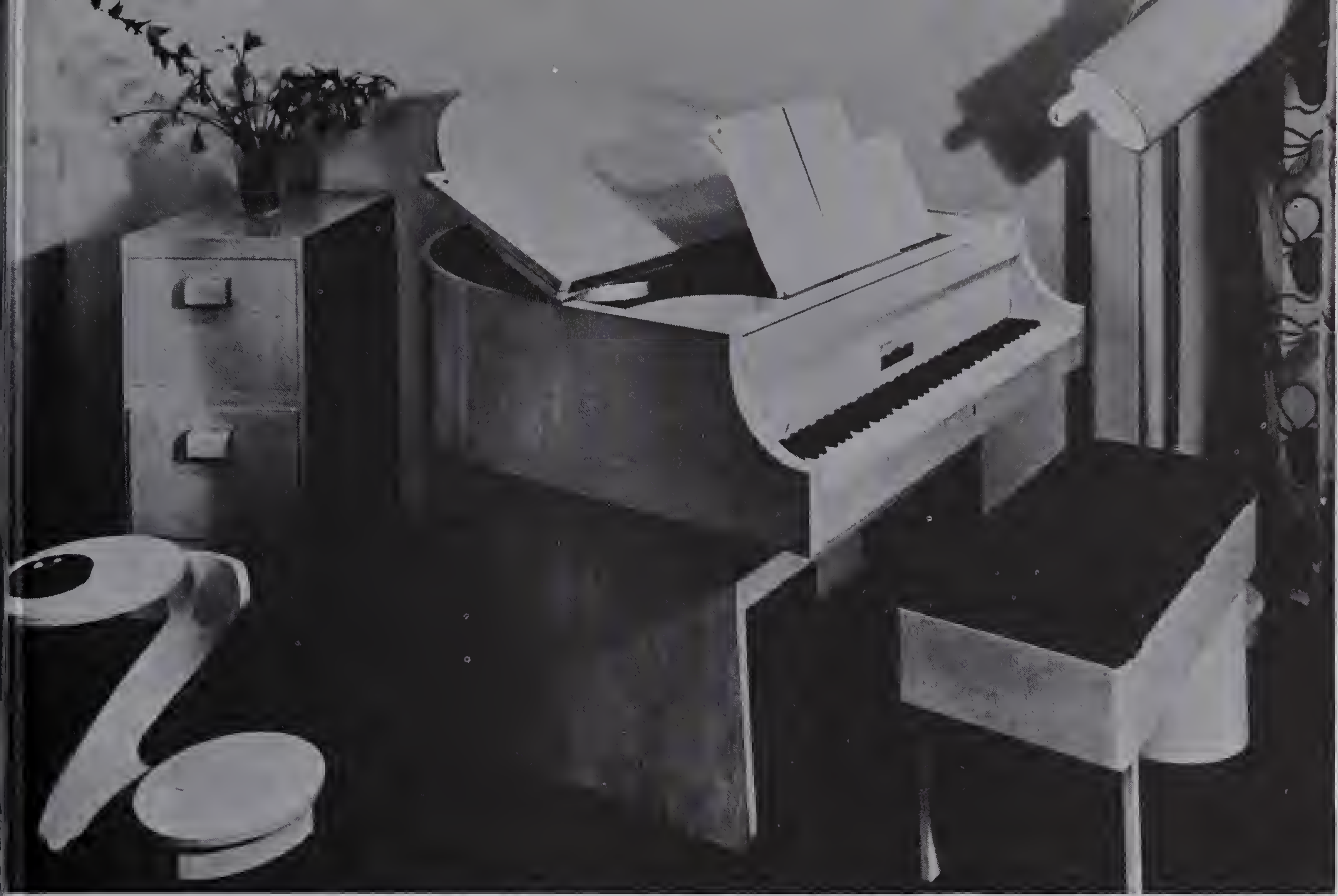
Picture **1** *is surely imitation carried to the extreme. The teapot is made to look like a stone-built cottage (even the handle is imitation stonework) while the lid is in the shape of a sundial. The function of the spoon,* **2**, *is entirely concealed by the shape, and it must have been very awkward to use. The electric light fitting,* **3**, *harks back to a lighting device of earlier ages. The sideboard,* **5**, *imitates what the designer believes to have been a style of the past. In all these objects the material and the purpose have been sacrificed to the needs of imitation. The cottage shape cannot possibly improve the efficiency of the teapot, neither does it bring out the best points of the material. The doors of the sideboard must have been difficult to make, but what is the purpose of this construction? Objects like these continue to be made, and to be purchased. How often have you seen tables like the one in picture* **4**?



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The designers of the furniture and utensils shown here meant to be modern at all costs, but have they achieved increased efficiency or better appearance? Does the function show in the shape, as it does in the modern school and railway station? What for instance is the object on the left in picture **6***? Is it a table? Why should a salt cellar be sloping? Do you think it is comfortable to drink out of a square cup? Although we saw that plastic cups did well to abandon old-established pottery forms, do you think there is any advantage in making them square? What shape would a person have to be to feel comfortable in chairs like the ones in picture* **10***?*

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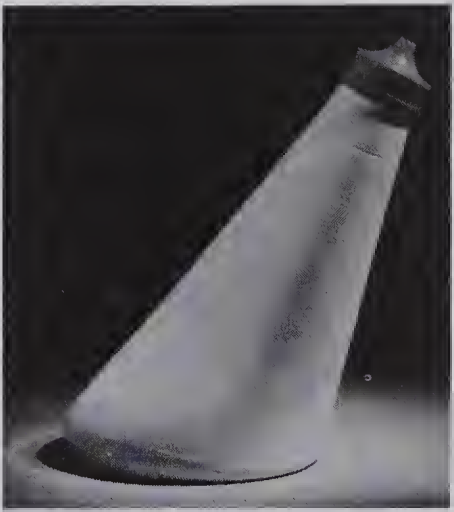

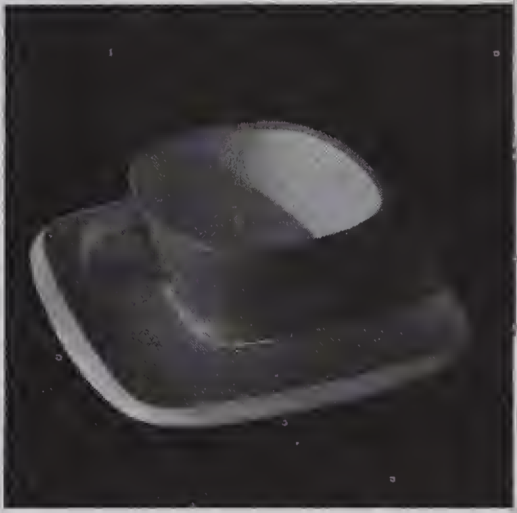

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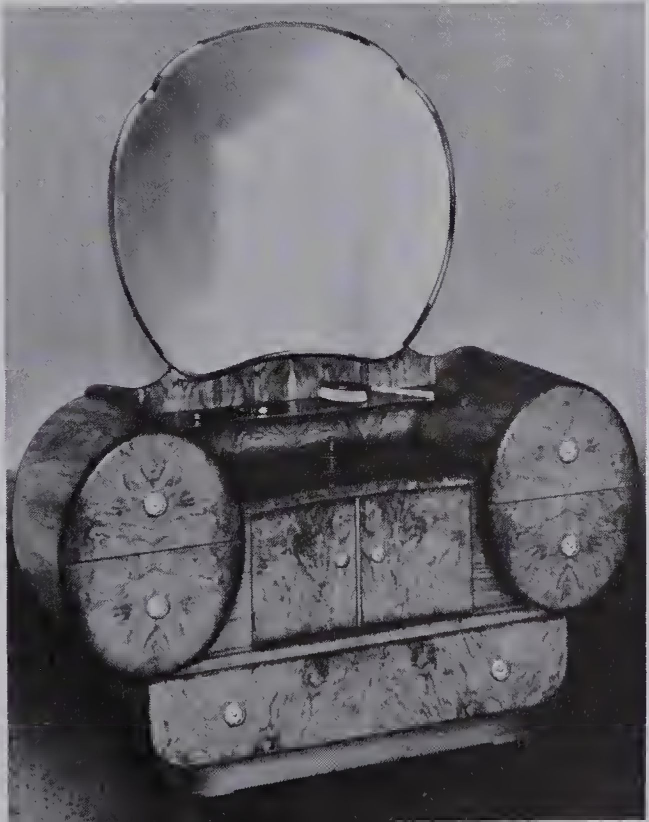
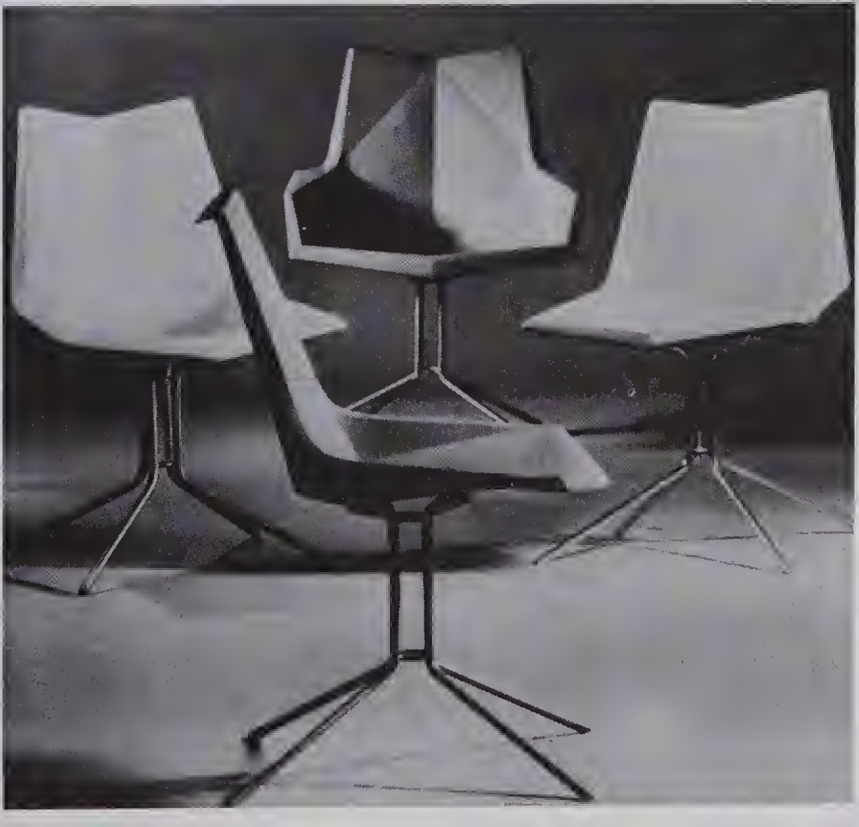
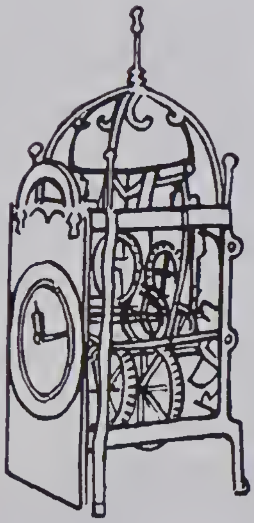




10

This electric clock, **2**, *is an imitation of a medieval clock,* **1**, *which worked of course on a different principle altogether. If you look closely you will see that even the words "Made in Great Britain" are in Gothic letters. Clock* **3** *is supposed to be a modern design. The shape is arbitrary and the various parts are unrelated, especially the legs. What are the reasons, if any, behind this shape? The three clocks in picture* **7** *are the outcome of a different way of thinking. Their mechanism is new and of an amazing accuracy. It runs for many months on an ordinary small battery. The designer gave it three different shapes for three distinct uses. The small clock is to be used mainly as a bedside clock and will therefore be handled often. Its shape is designed to invite handling, like a pebble. The larger clock is mainly for use in the sitting room. It need not be handled often, but only picked up from time to time for cleaning, when the narrow neck provides a good grip. Such a clock must – or should – have a "presence" and a dignity of its own. There is also a third model, for fixing to a wall. The faces of these three clocks are tilted at different angles,* **4**, **5**, **6**. *The reasons for this can be seen in the designer's drawing,* **8**. *The sitting-room clock is likely to be at a higher level than the bedroom clock and is therefore tilted less. Wall clocks are normally above eye level, hence the forward tilt of the wall clock.*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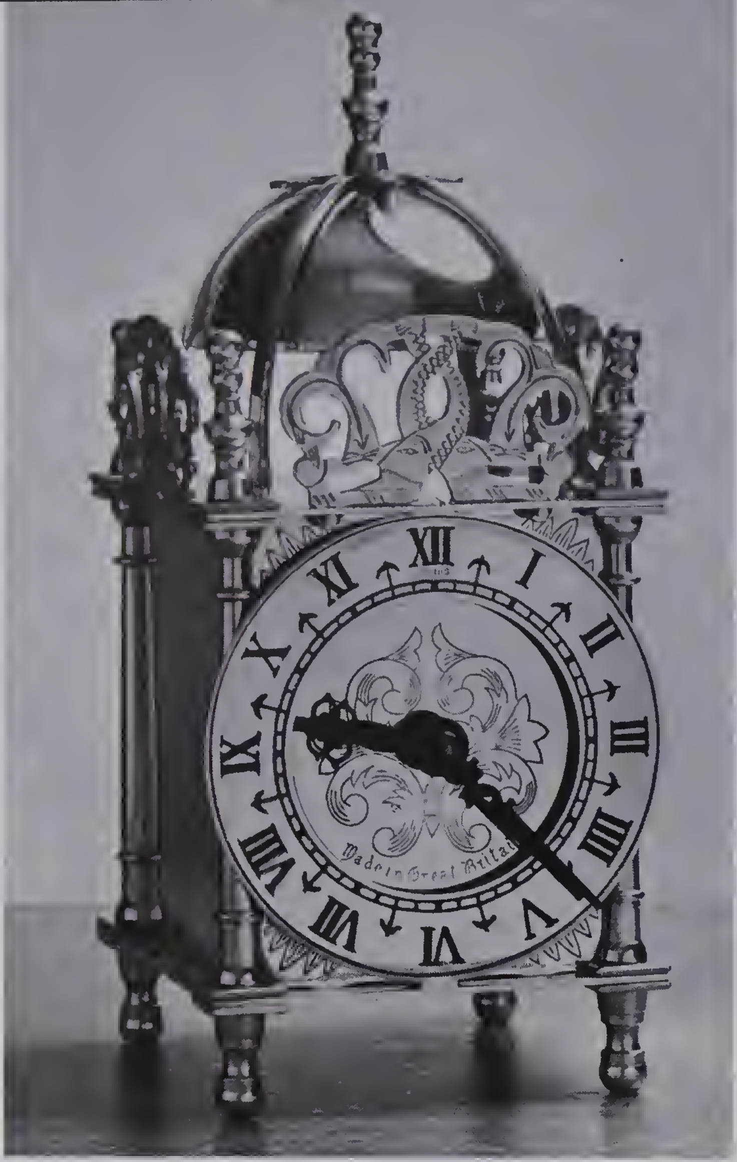

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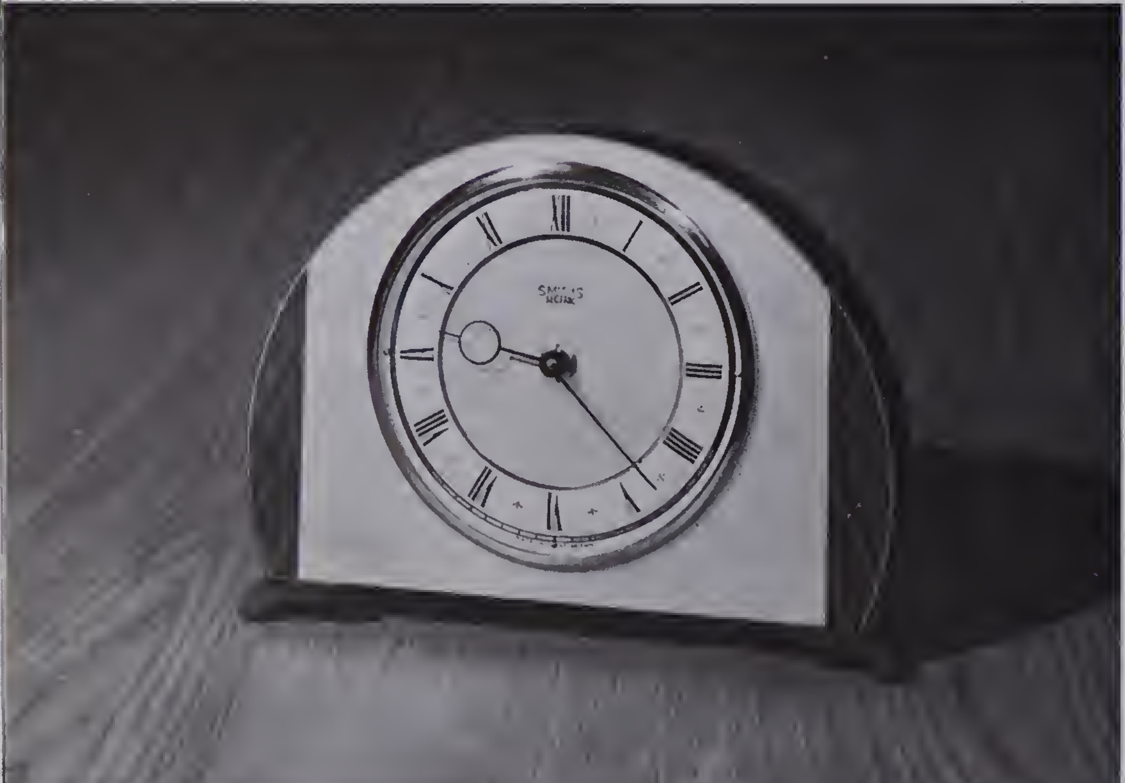
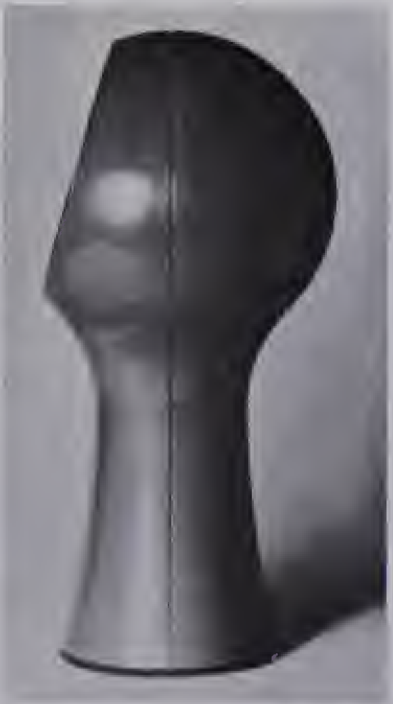


3

4

5 **6**



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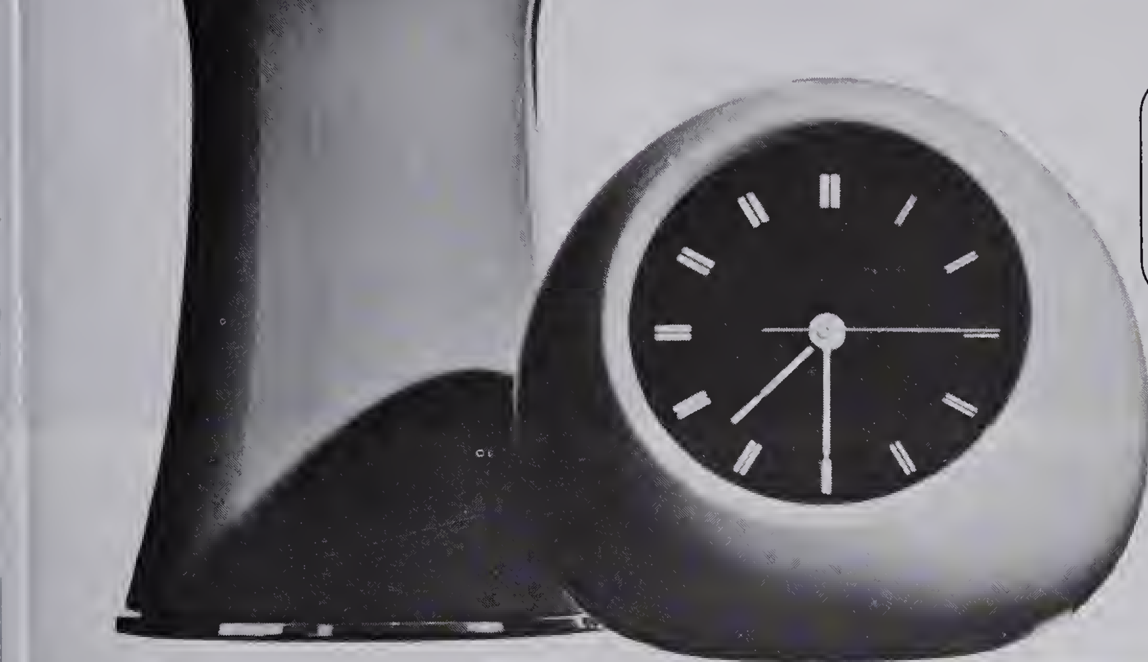
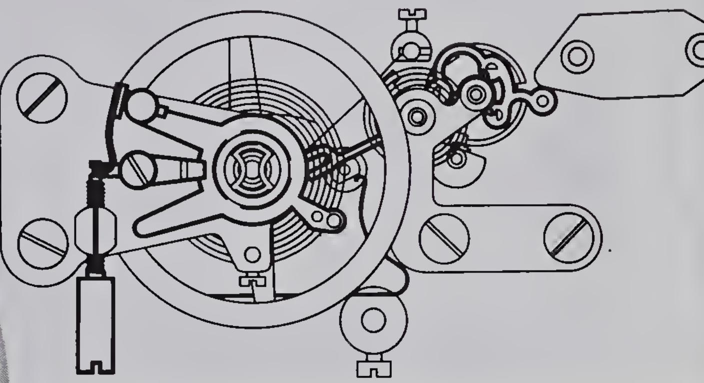
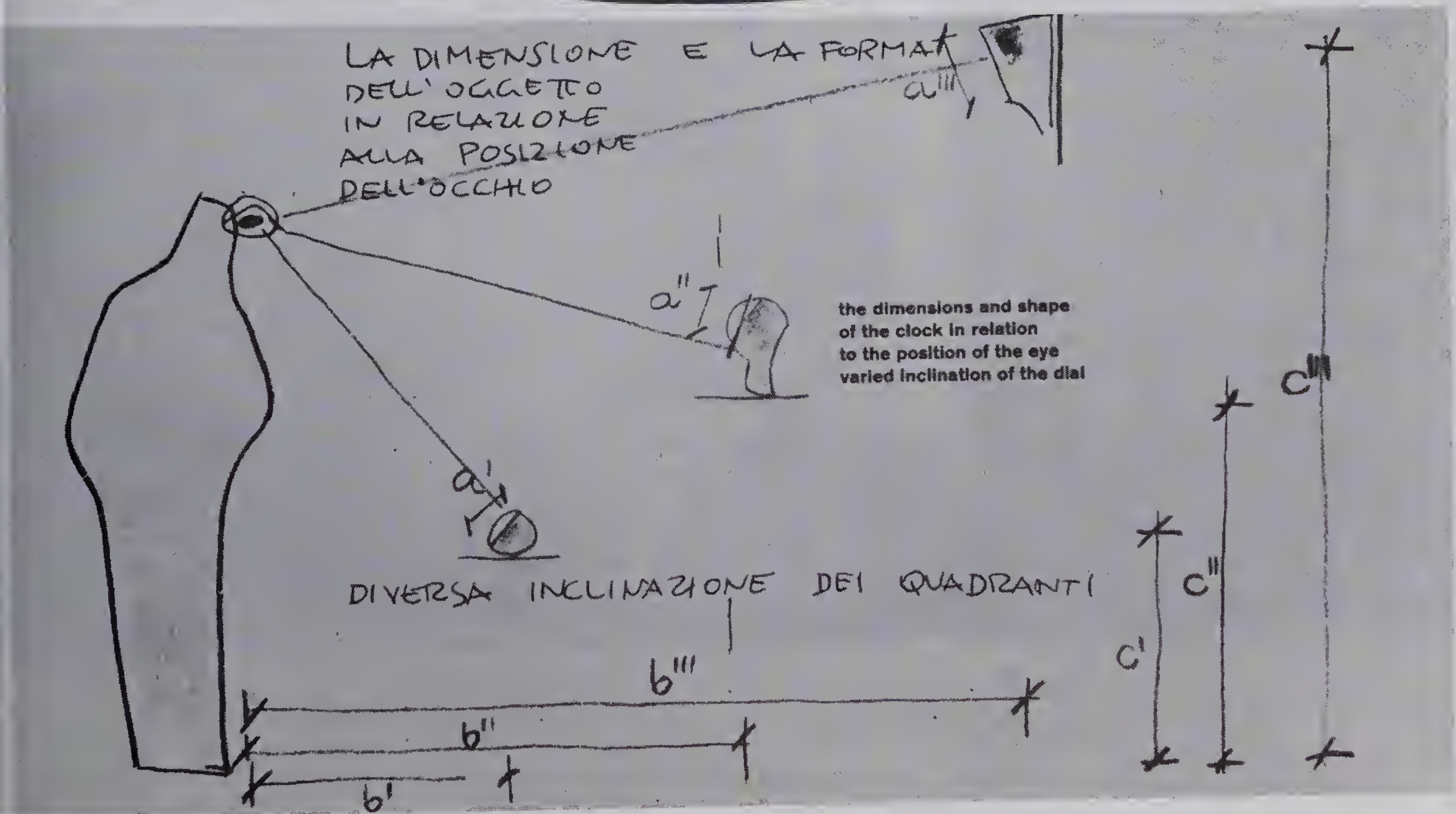


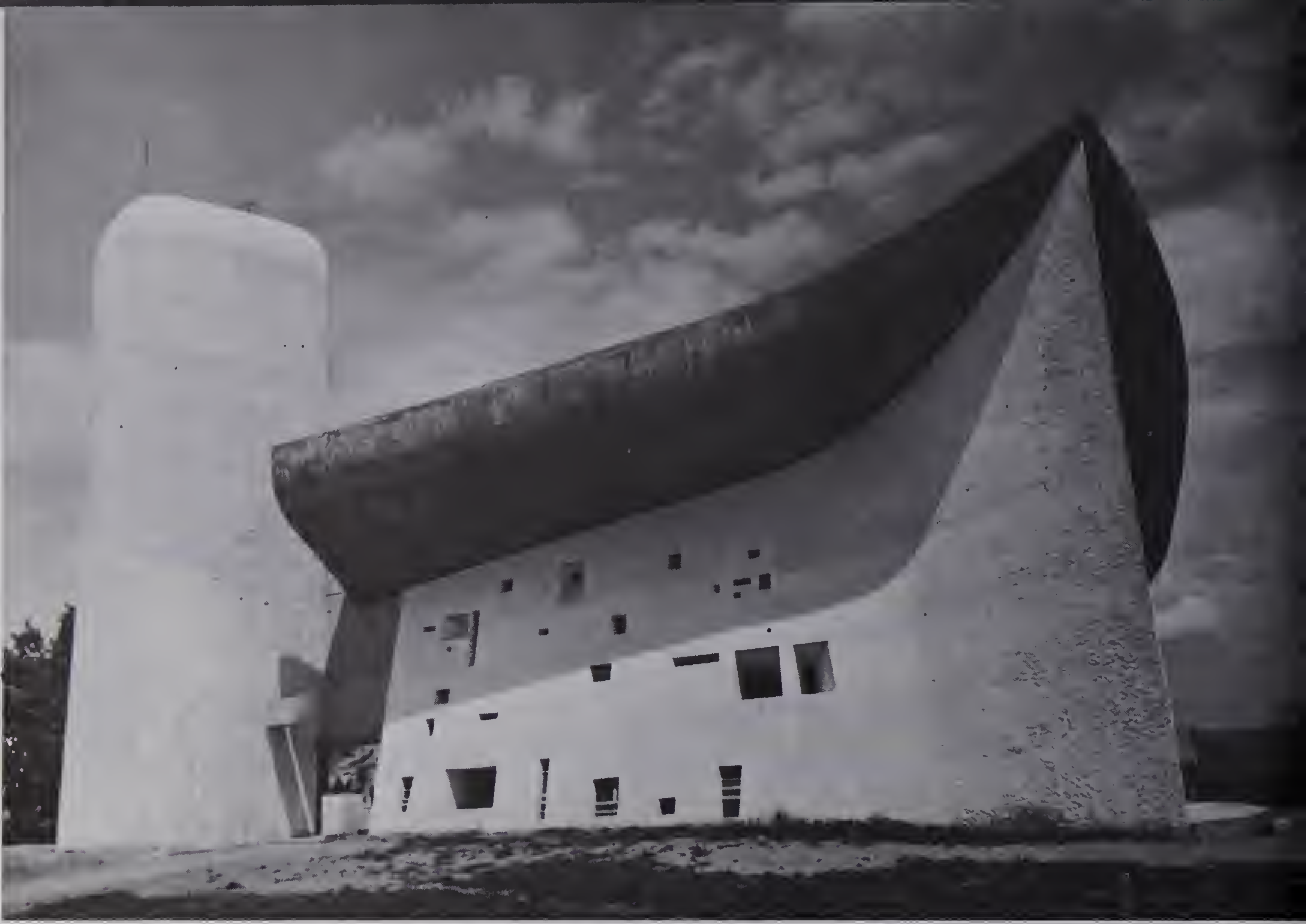


These clocks, in their easily opened plastic cases, seem to express not only their purpose but also their precision.

8

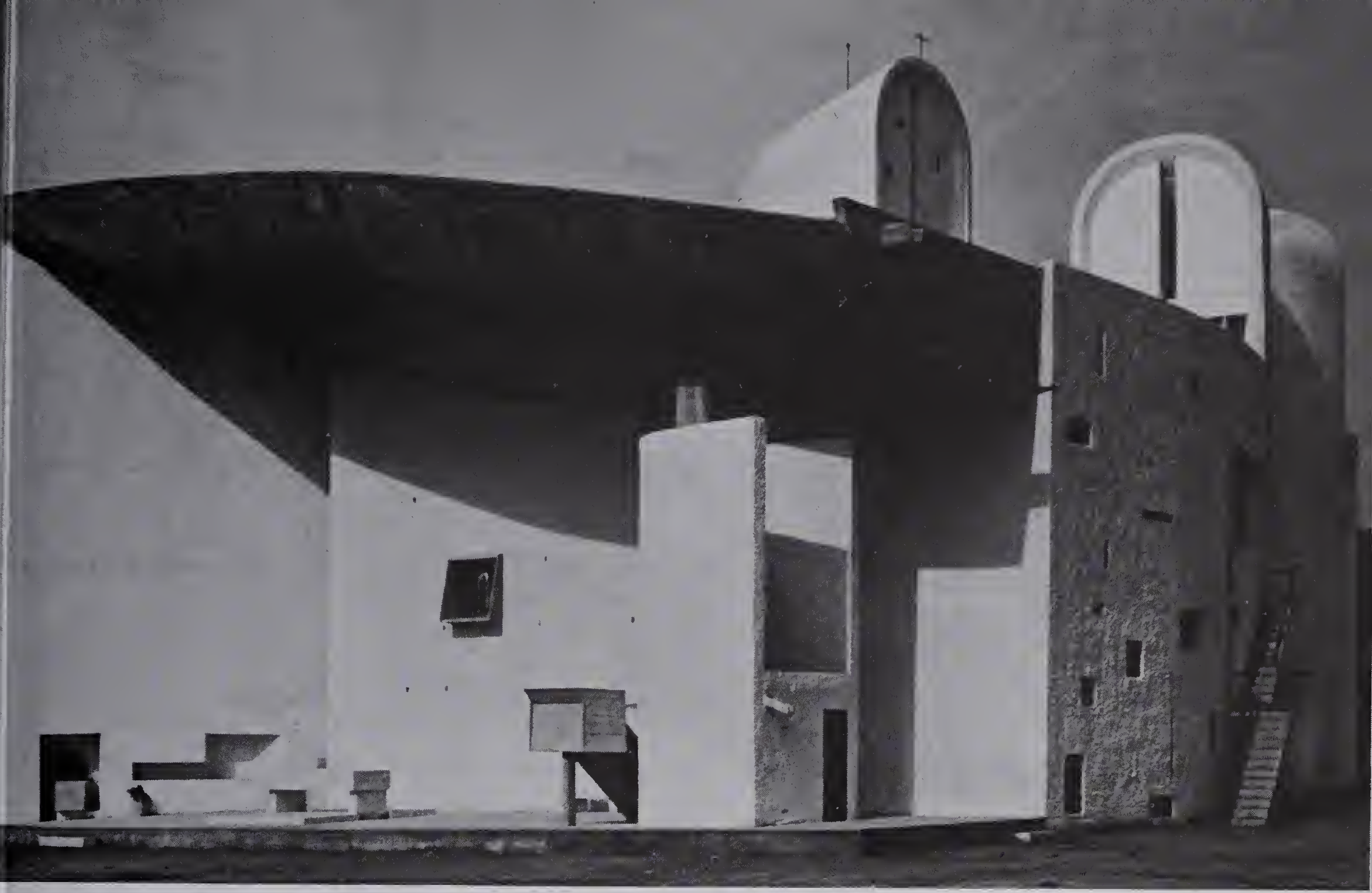

LA DIMENSIONE E LA FORMA DELL'OGGETTO IN RELAZIONE ALLA POSIZIONE DELL'OCCHIO
a'''
a''
a'
DIVERSA INCLINAZIONE DEI QUADRANTI
b'''
b''
b'
C'''
C''
C'

the dimensions and shape of the clock in relation to the position of the eye varied inclination of the dial


1

2

These pictures show one of the most famous chapels in Europe, the chapel of Notre Dame du Haut, near Ronchamp in France. It was designed by Le Corbusier, one of the great architects of our time. At a first glance, you may think it looks rather unusual but when you have studied it for a little while you will find that there is really nothing strange about it. It is in fact a logical shape. The old stones from the chapel which stood on the same hilltop and which was destroyed during the second world war provided much of the building material, but other materials, such as concrete and aluminium (for the covering of the roof) were also used. The half-domes which top the towers are of cement. The plan of the chapel, **2**, shows the curved walls which give added strength without extra thickness and so avoid the need for buttresses.
The roof, which is a shell consisting of two skins of reinforced concrete, rests on these walls, almost suspended from the three towers, **5**. There are three small chapels within the building, each with its own tower to admit light from above.



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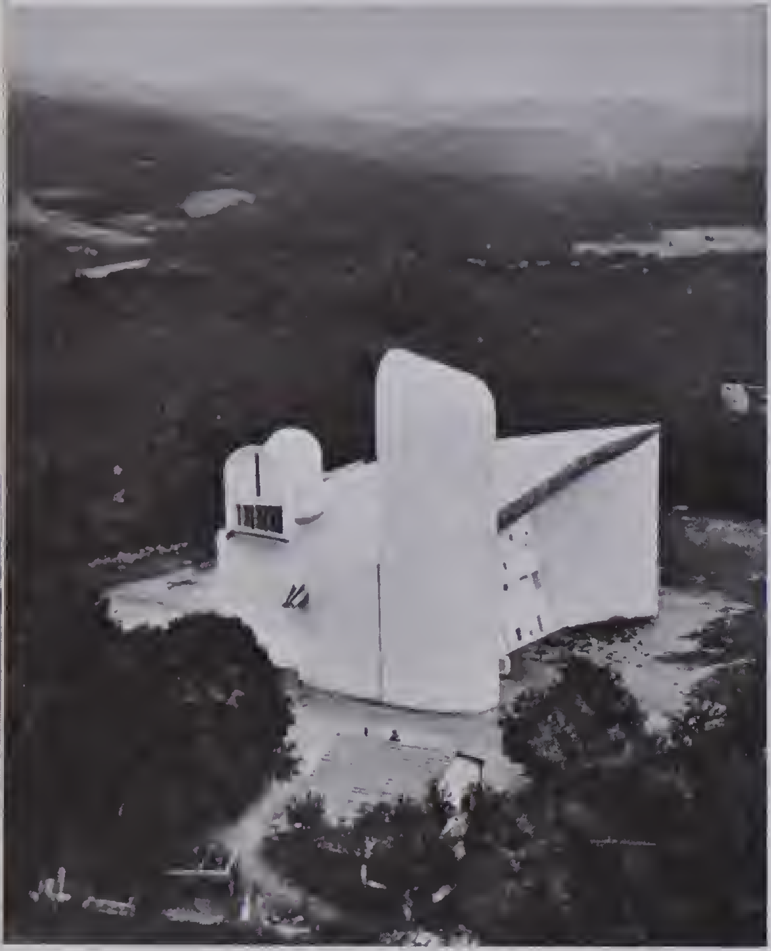
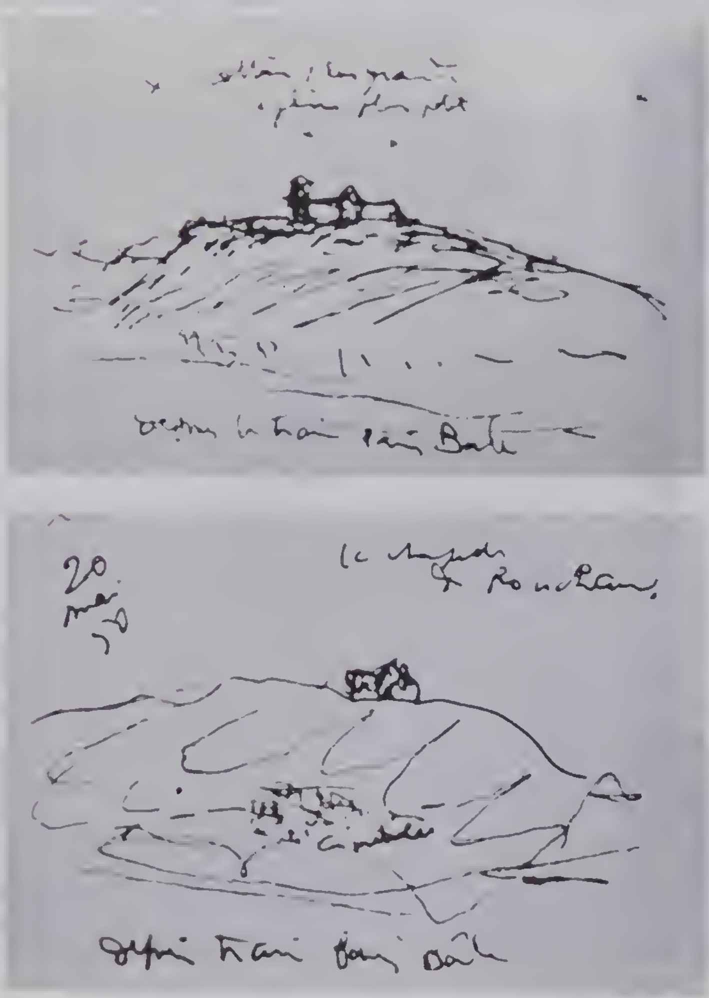
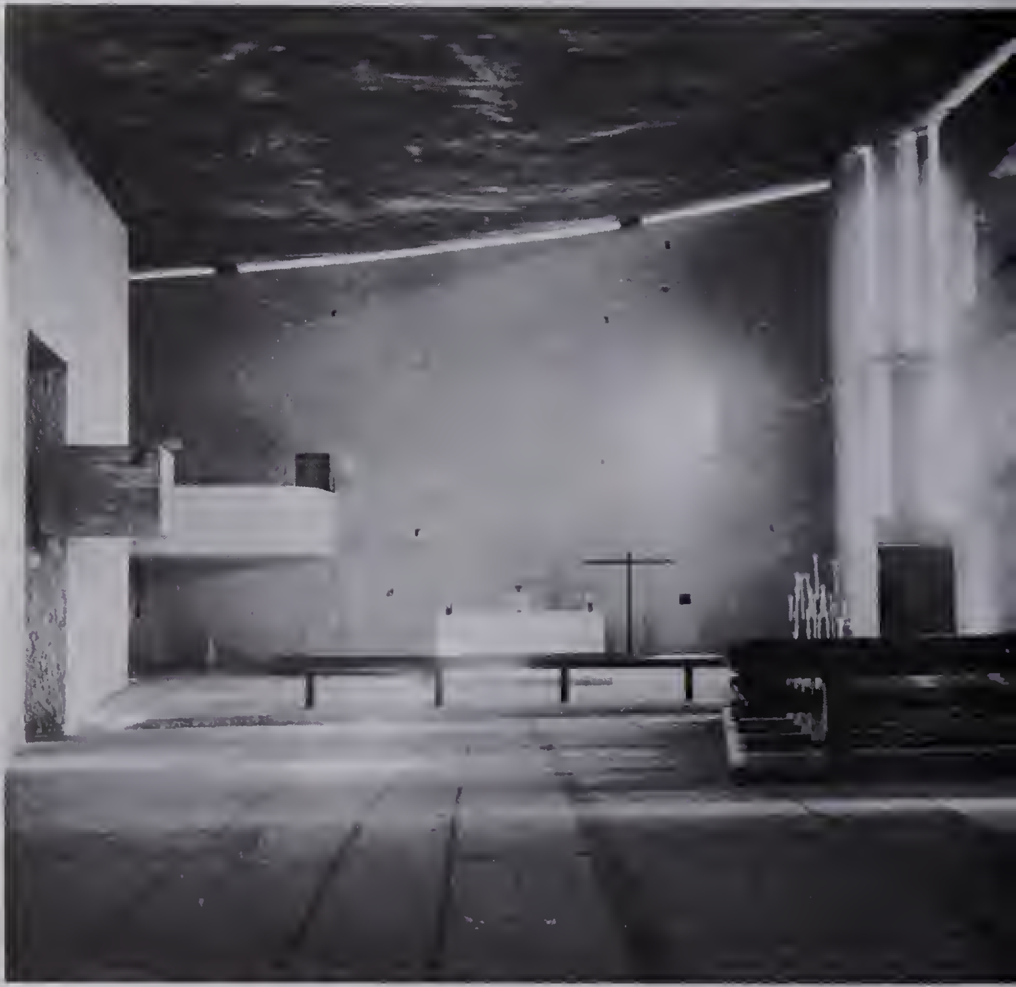
1



A building such as this may be considered from many different points of view. We can see the masterly way in which the materials have been used. The contrast between the white rendered walls and the rough concrete roof helps to give the whole building its character. We may admire the structure, so well suited to the materials and to the purpose of the building. As one walks round the chapel one is impressed by the variety of its form, which has at the same time the unity of a very large piece of sculpture. In spite of the small size of the chapel there is no feeling of cramped space. It comes as a shock to realise that the main nave is only a little more than forty feet wide, **3**. So skilfully has the space been utilised that one does not become aware of any lack of it. Neither can one fail to be struck by the way in which the chapel, placed on the brow of the hill, fits into the landscape, **1**. One of the first things Le Corbusier did when he started to think of this chapel was to make numerous sketches of the landscape, **2**, to make sure that the new building would match the character of its surroundings.





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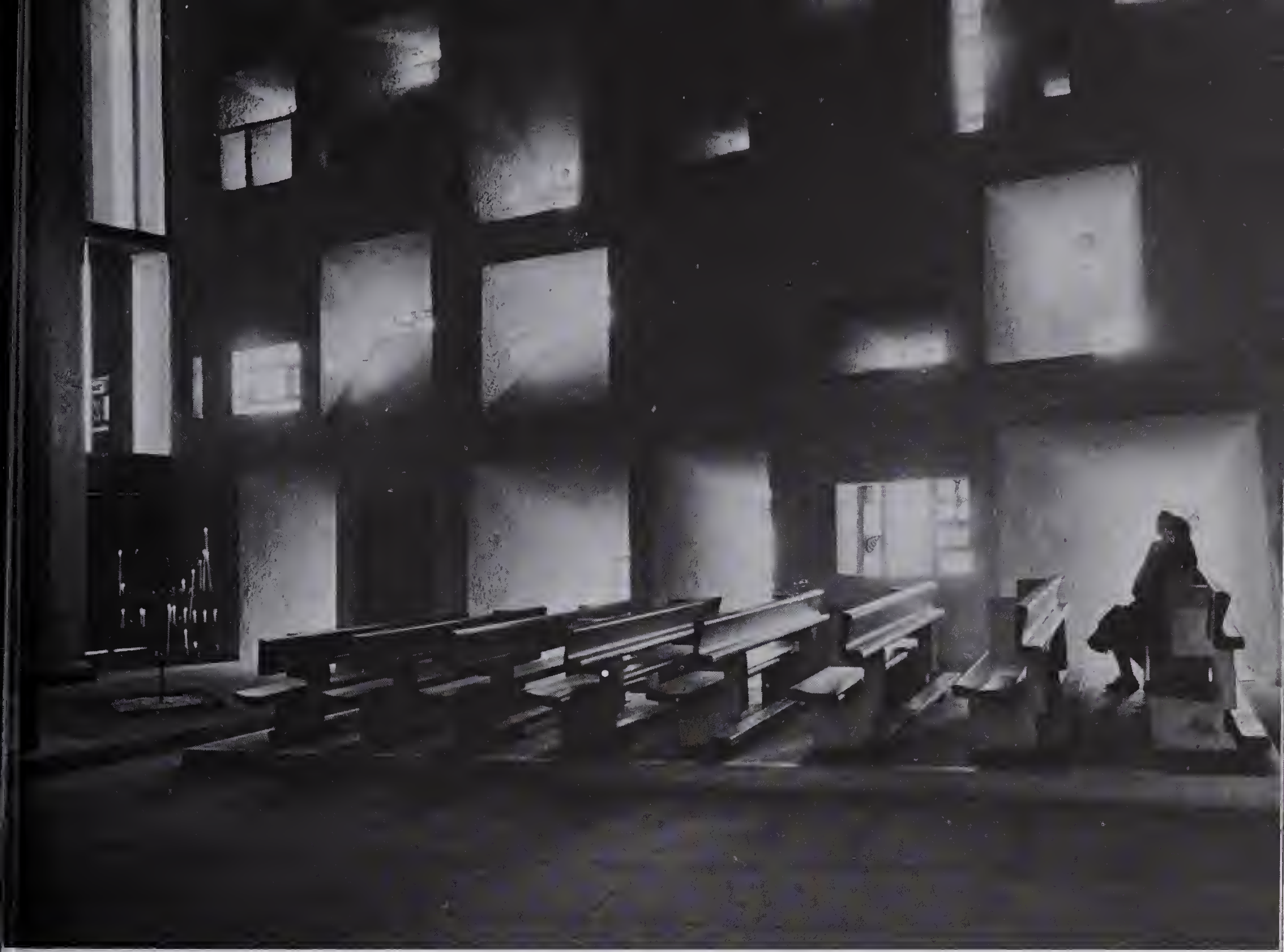

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Lastly, it is quite obvious that the chapel serves its purpose well. If an architect of a church does not create an atmosphere of peace and of prayer, he has failed in his purpose. This picture, **4**, of the interior of the chapel will give you an idea of how well its architect has succeeded, and his success is the more striking when you consider that it has been achieved without copying the things we are used to in other churches: stained glass windows, vaults, pillars, elaborate ornaments.

Much more could be said about the Ronchamp chapel, but you will already begin to understand that, although it is unlike all other churches you have seen, it is a logically planned shape. As well as being a logical shape, it is also functional, just as a Gothic cathedral and a sea shell are functional.

1

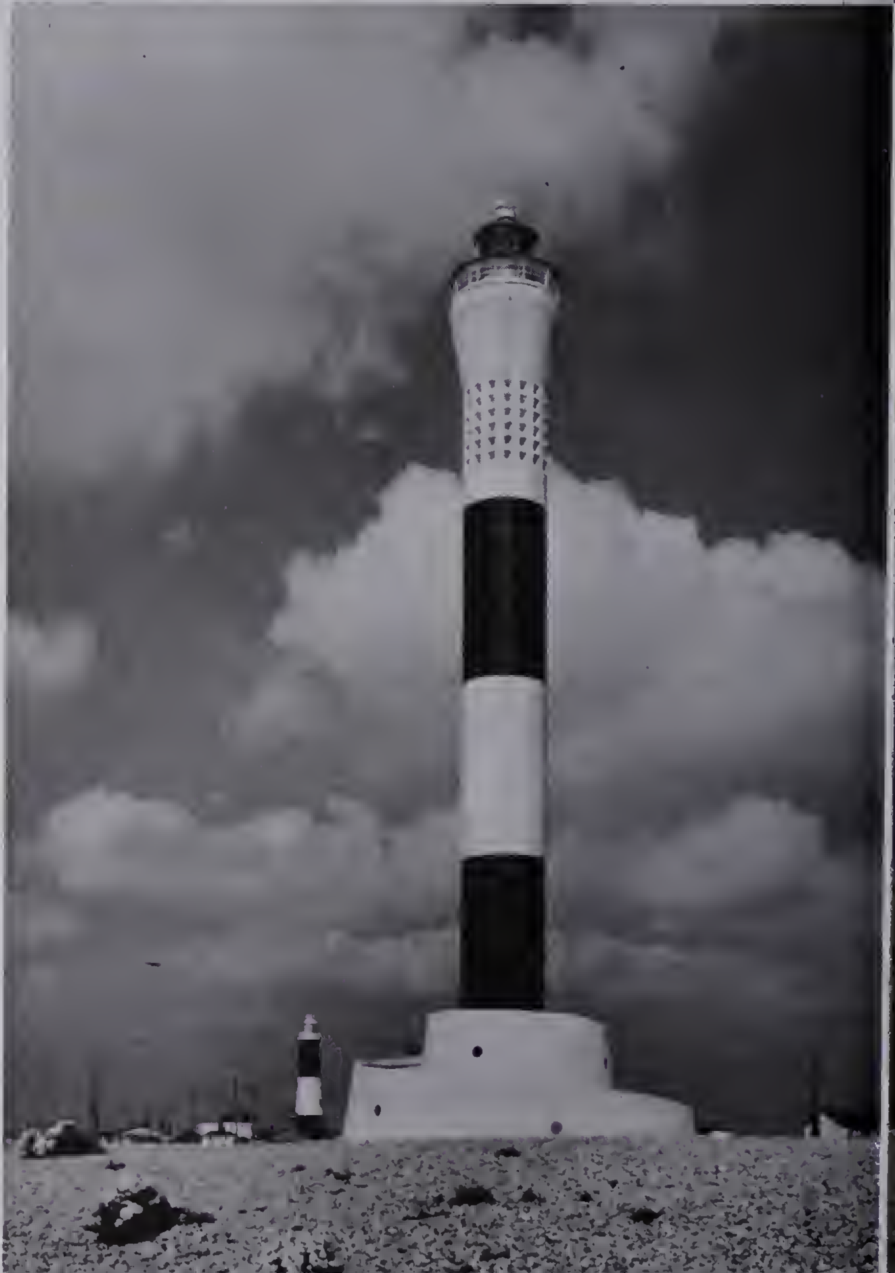
This Indian observatory, **1**, *was built in the eighteenth century. Its designer did not attempt to disguise its shapes or its purpose. He built it with honesty in what he believed to be the best possible way, and in doing so he produced a magnificent shape, just as Le Corbusier did in Ronchamp.*

2, 3, *The new lighthouse at Dungeness, Kent. It is a twentieth century lighthouse, just as the clocks on page 81 are twentieth century clocks.*

The shape of the older lighthouse seen in the distance is due to the fact that greater strength and therefore thicker walls were necessary towards the base. The modern lighthouse is built of reinforced concrete. Extra strength could be given to any part by further reinforcing rings inside the walls. It was not necessary to vary the thickness of the walls.

2

3



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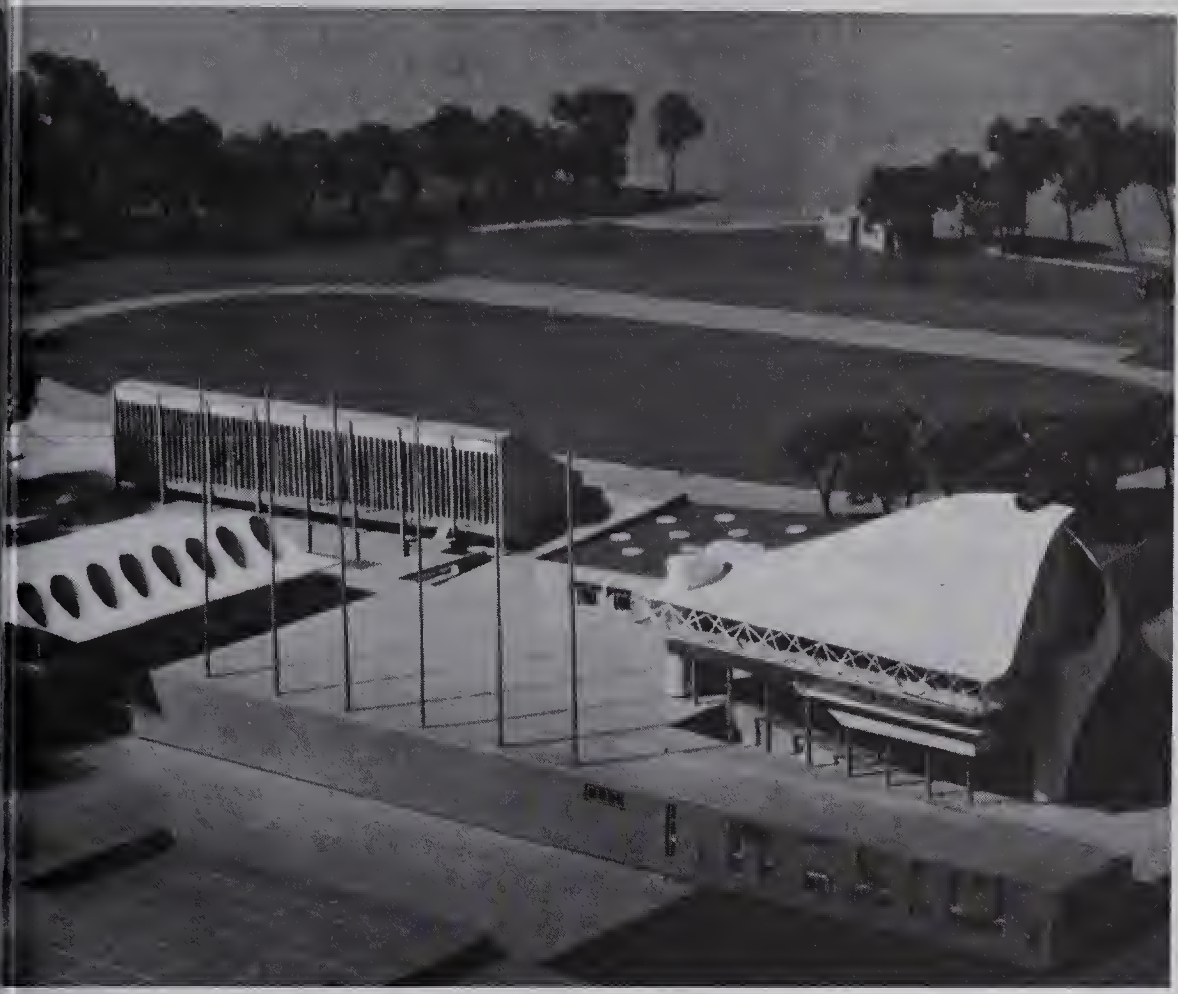
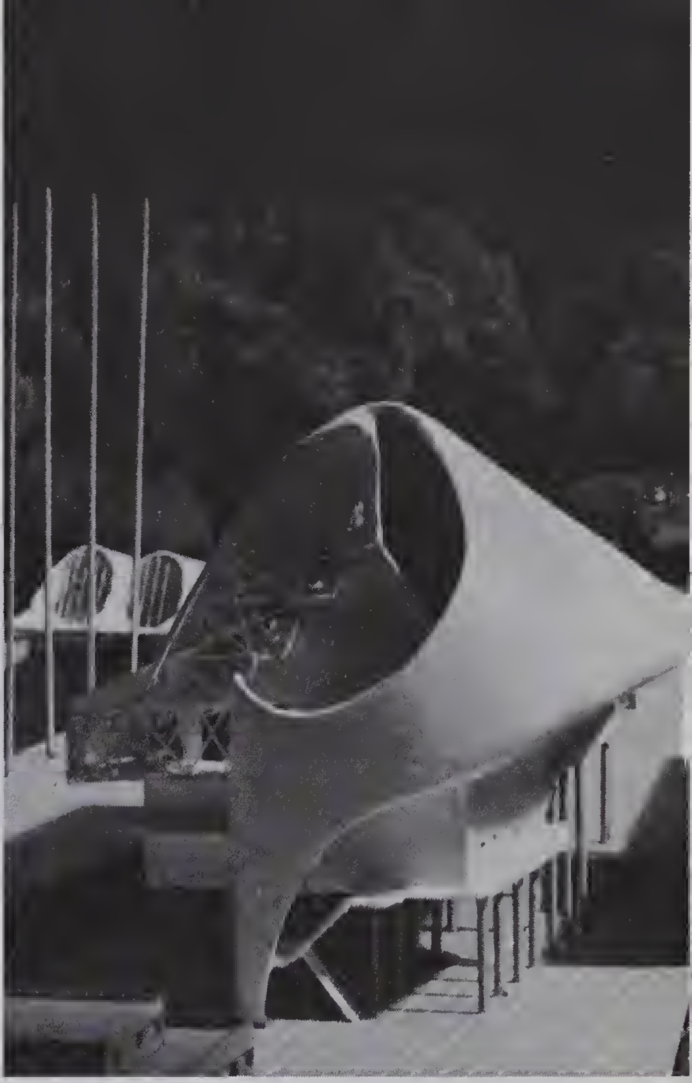
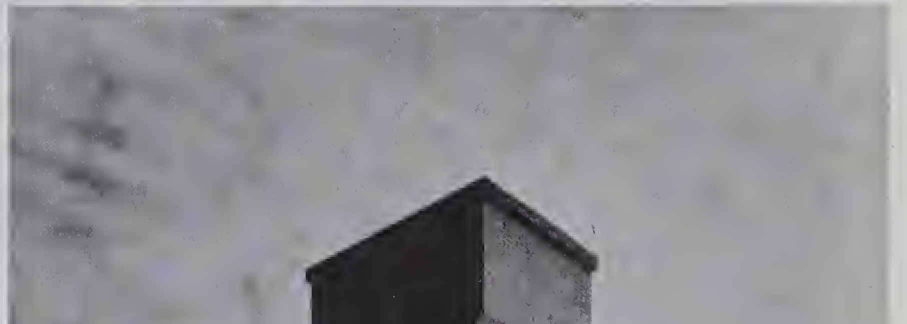




4, 5. *A model of the covered swimming pool at Birmingham University. We can see quite clearly what this building is designed for and what the building materials are. A swimming pool requires a much higher roof at the end where the diving boards are than at the other end, and it is this requirement that results in the shape of this thin concrete shell. The building also combines in its structure several flights of stairs and a gallery. Many swimming baths look like other buildings from the outside, and do not reveal their purpose by their shape. The shape of the Birmingham University swimming pool on the other hand seems to express the idea of a swimming pool. Picture* **4** *shows how the building fits in with its surroundings. The low building at the left of this picture is a gymnasium with eight overhead windows. This arrangement allows the maximum wall space for apparatus, wall bars, etc.*

The sand hopper on the M1 motorway is also a functional shape. In its own simple way it is a much more satisfactory structure than a pretentious building like **3** *on page 73. The architects of that building tried to make its appearance impressive. This sand hopper, which is a functional shape, comes closer to being good architecture.*



6

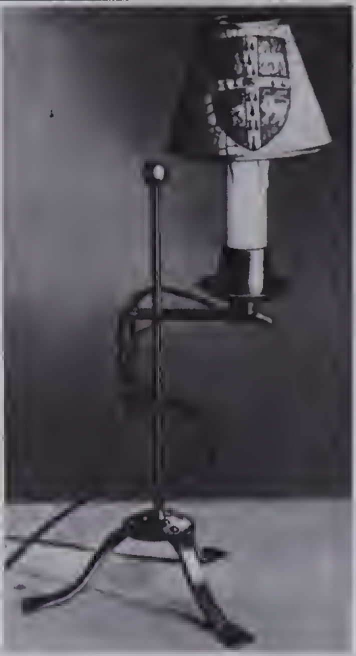
TO SUM UP

When a designer works without a real understanding of his materials and of their relation to purpose, he makes bad shapes or imitates other shapes. If we buy badly designed shapes we become partly responsible for their designer's shortcomings. It is important to remember that a lowering of standards affects both the designer and the public for whom he designs.

A good man-made shape is one that is honestly designed; that is to say, where the designer has used his knowledge and his skill to produce the most efficient shape for its purpose. Such shapes originate in the ideas, functions, materials and methods of their age, and express the age to which they belong.

EXERCISES

1. Explain which of objects **1** to **4** seem to you to be good shapes and which bad. In what way has the designer made use of his materials? Say what you think about them. (What do you think **3** is?)
2. In what way are we responsible for bad shapes?
3. The water tower (**8**, page 69) shows how the right material and the right method can express the purpose of an object. Find other examples of this, a locomotive design for example.
4. Find examples of objects in which the function is hidden. Compare these to the objects in question 3 and explain the main differences.
5. An honestly-made object expresses the spirit of the time in which it was made. For instance, a Romanesque church expresses the need for protection, the clocks (**7**, page 81) express our feeling for scientific accuracy. Find some objects which do and some which do not express the spirit of their times. Do you think this is an important point to bear in mind when looking at man-made things?
6. When people are excited by the adventure of developing and perfecting things, as for instance, the Greek and Gothic builders must have been, they do not think of imitating others. What follows from this?
7. Why do you think the people in picture **2** on page 70 may have been attracted by imitations?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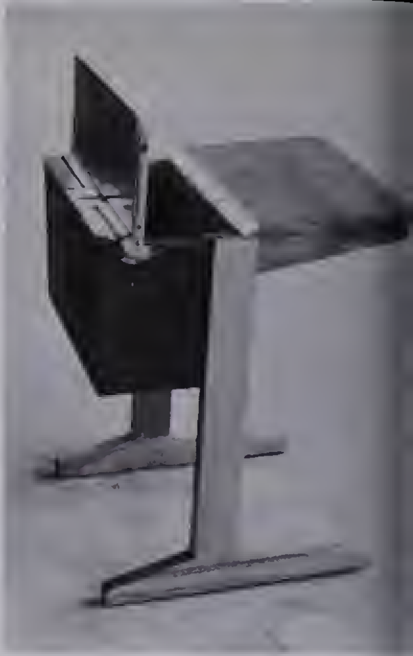
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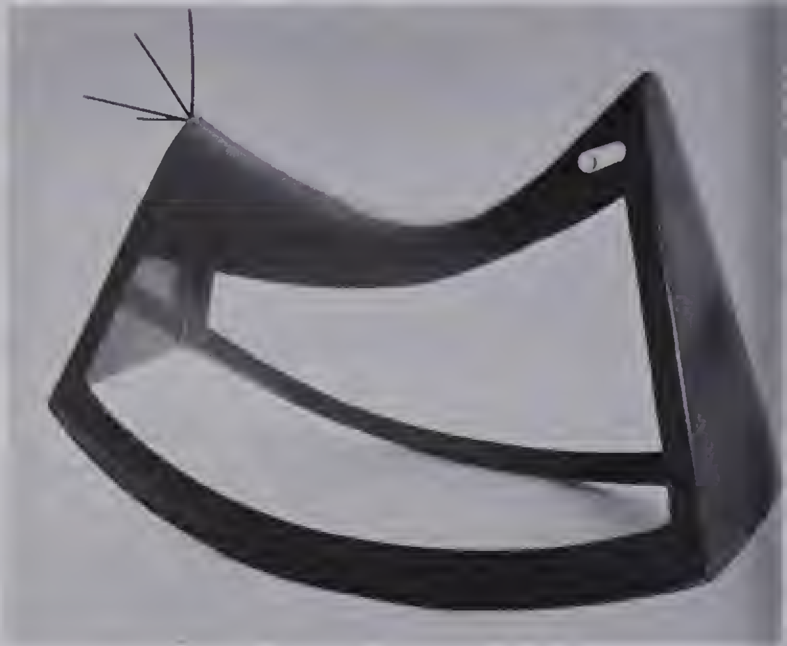
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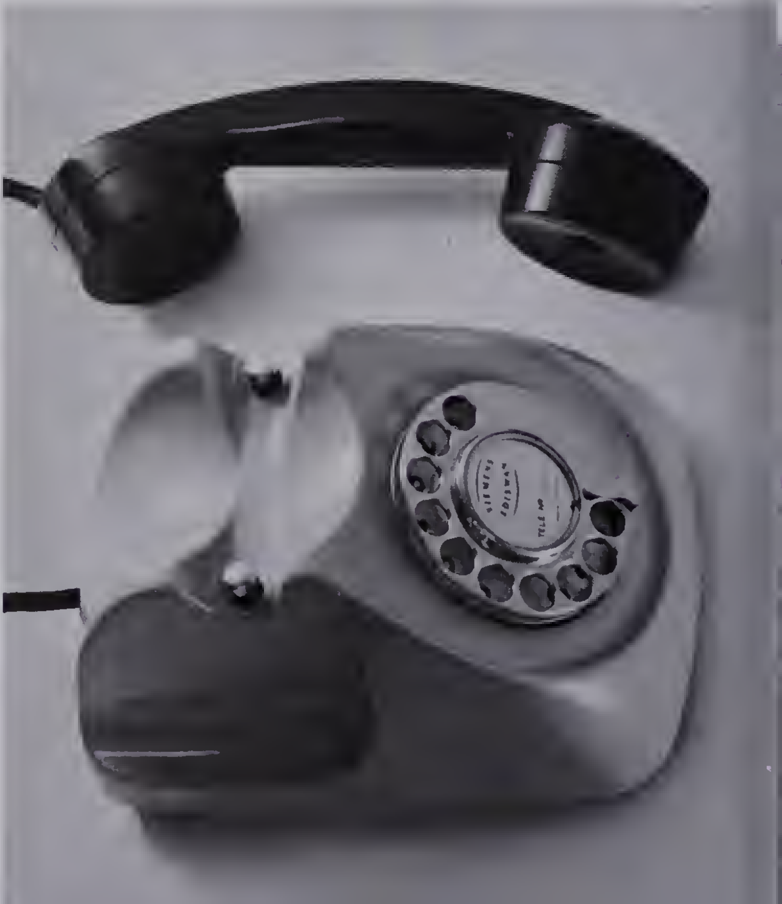
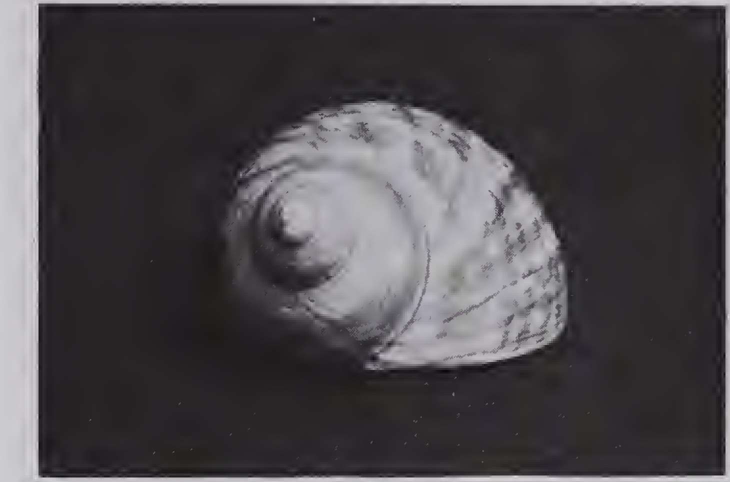
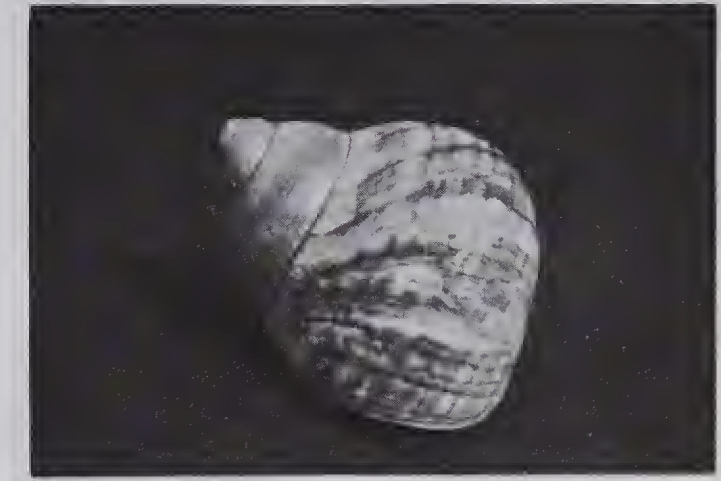

4

5

The surface of form: pattern and colour

We have been discussing forms, and how they come about, but there is still one aspect of form to which we have not paid much attention: the surface of form. If you tried to describe to a friend an object you have just seen, you would probably begin by explaining its shape, but soon you would begin talking of its surface: its smoothness or roughness, its colour, its pattern, and other qualities. You would feel that the shape alone does not fully describe the object, and rightly so, for the surface is a very important part of the form. You only have to glance at some simple natural shapes, an orange, or a nut, or a sea shell, to realise this. If you look around you a little more closely you will soon come to the conclusion that a shape is not enough to describe an object or make it recognisable; its surfaces, its patterns and colours are what make it recognisable. A nut without the pattern we normally associate with it is simply not a nut to us; we should hardly recognise it. If we saw a freak orange with a skin as smooth as the surface of a billiard ball, we should find it difficult to recognise it as an orange. On the other hand it is sometimes possible to tell what an object is by just looking at a small part of its surface pattern. The patterns in these pictures can be said to belong to their forms, they are so well matched, and the reason for this is easy to find.

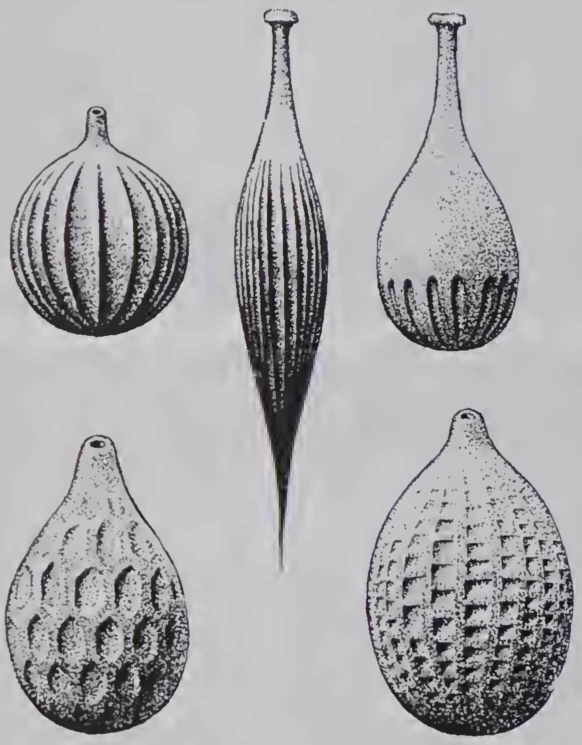




Natural patterns grow with their forms and develop in the same way as the forms. We saw on page 50 that there is a relationship between the pattern inside the bone and the shape of the bone: the interior pattern is created by the same forces which create the shape. Without this pattern the form could not exist. Surface patterns are similarly linked to form. The pattern on the shell of a nut is also the pattern of its structure; without this structure the shell would collapse. The pattern of veins covering the surface of any leaf is also the pattern of its structure. If you examine other natural forms you will see that the pattern does not merely decorate the form; it is an essential part of it. Because both form and pattern are created at the same time, by the same process, there is a relationship between them and it is this relationship which makes them so harmonious.

To study this relationship in the larger animals and plants would be too difficult for us, but there are some good examples to be found amongst the simpler animals. In pictures **1** and **2** you see a number of very small sea creatures called Lagena. They are all quite simple and straightforward forms and all have a surface pattern which varies from animal to animal. In each case it seems as though a pattern developed which was absolutely right for one Lagena but not for any other. This is an example of perfect relationship between form and pattern.

The following can give us a clue to the origin of the patterns. Soft materials which set if left to stand, gelatine, for example, shrink as they dry out, and shapes made of such materials become smaller. The outer part of such shapes sets first, and some materials form an outer skin while the soft inside still goes on drying and shrinking. This outer skin cannot follow the shrinking inner mass and arranges itself in a series of folds and hollows, **3**. The pattern of these folds and hollows depends on the shape itself. If the setting shape were like a sphere, then each hollow would be surrounded by another six and gradually a pattern of six-sided shapes – hexagons – would result. If the shape were a distorted sphere, elongated at the poles, then the folds of the outer skin would arrange themselves in long ridges from point to point. In this way each



1

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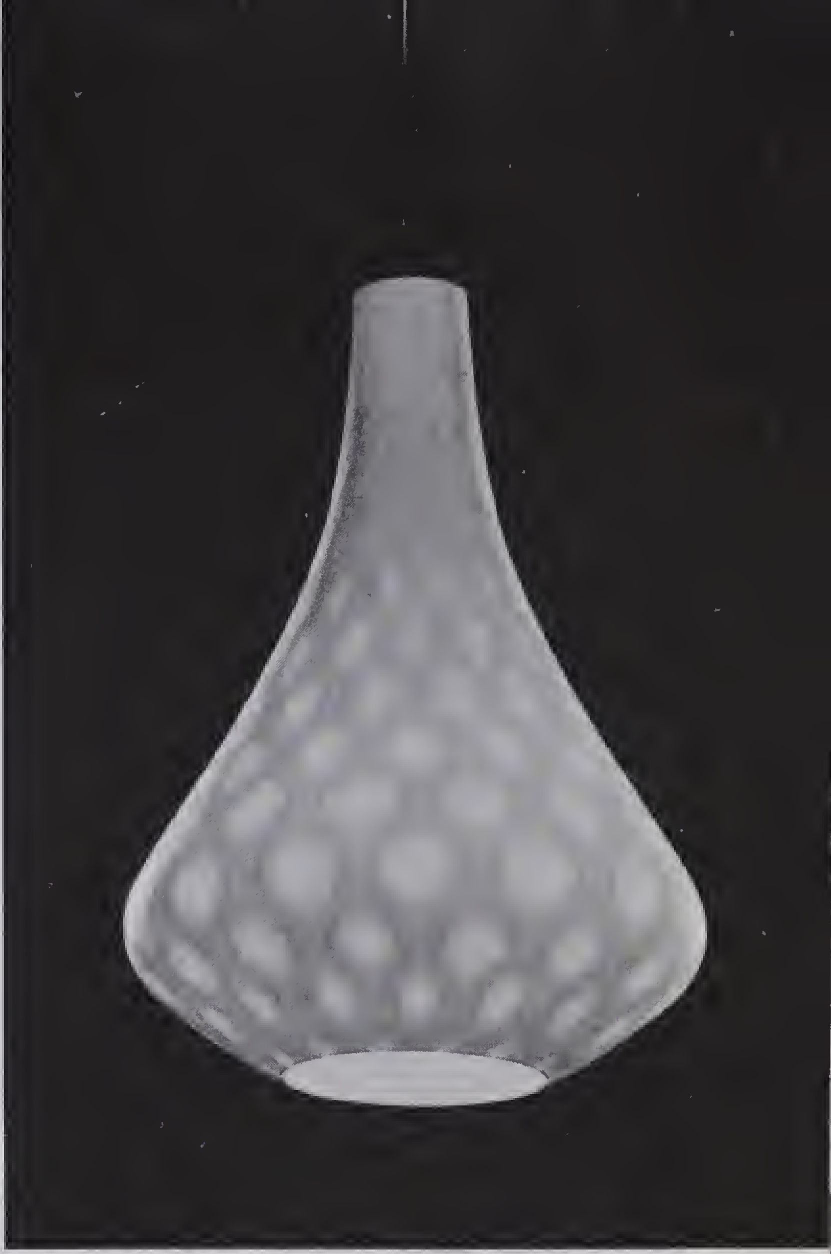
3

shrinking shape causes a different pattern on its surface. It is, of course, not quite as simple as this; many other things can change the pattern, the thickness of the outer skin, for instance. But on the whole we can say that every variation in form produces its own characteristic surface pattern. You may have seen similar combinations of forms and patterns in man-made things, pottery, for example, or lampshades made of glass or plastics. Man sometimes arrives at satisfying combinations of form and pattern without direct imitation of nature. The people who made the objects in pictures **4** and **5** must have thought that these patterns looked right on these particular shapes; they must have sensed a relationship between the shapes and the patterns. In nature this relationship between form and surface pattern comes about through the workings of natural laws. In man-made objects it is achieved through man's conscious or unconscious search for true relationships. As we have seen, the results produced by man are sometimes strikingly similar to those seen in nature.



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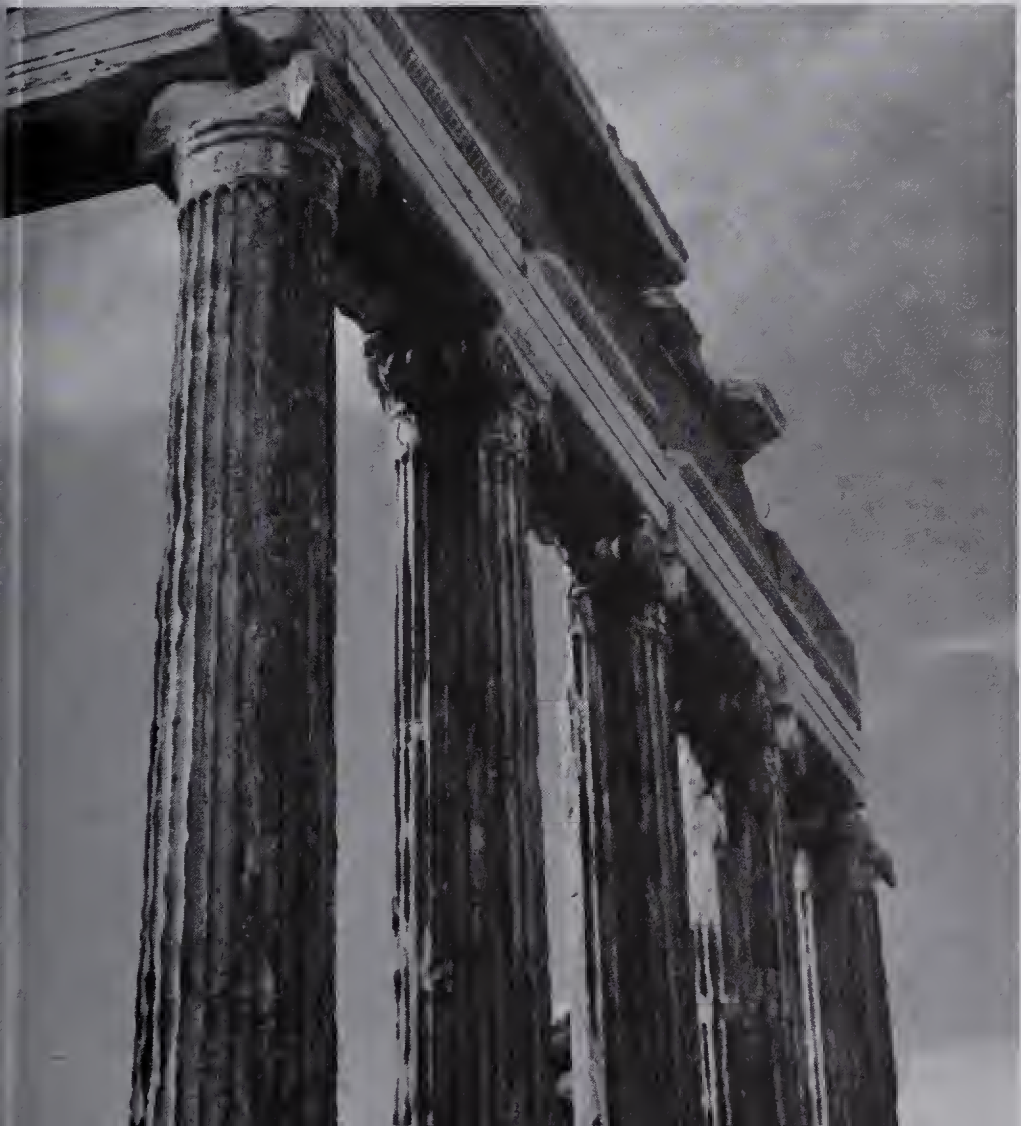

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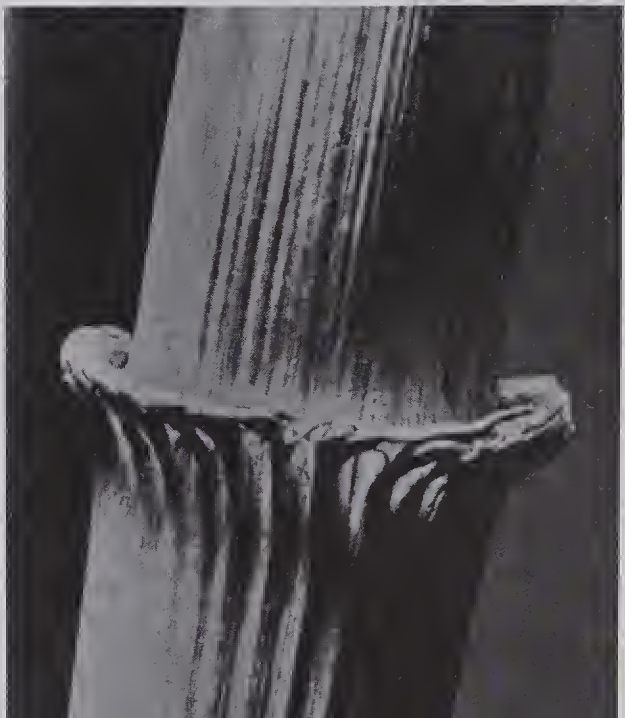
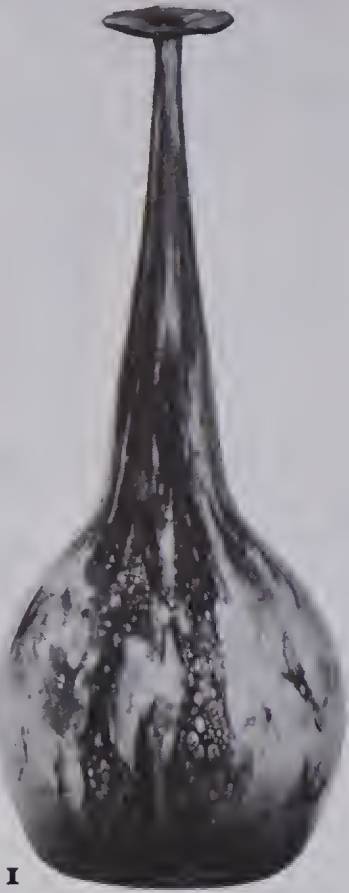


5. *Greek columns* **6**. *An enlarged photograph of the stem of a plant*



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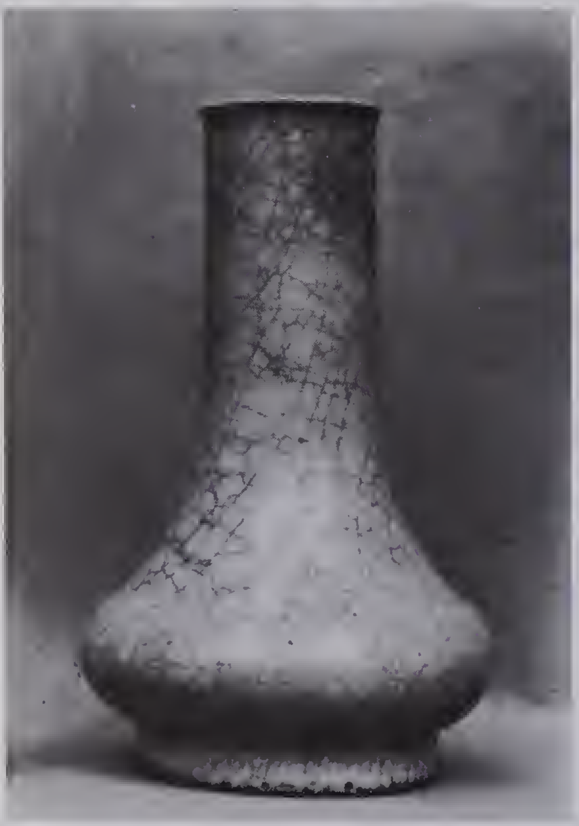

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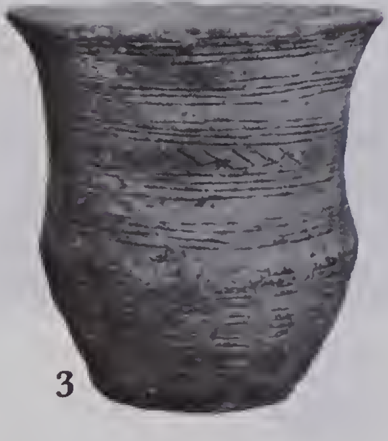
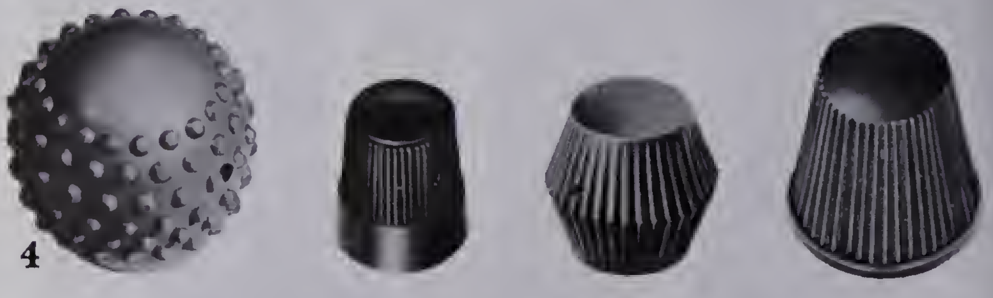


3

The pattern on this glass bottle, **1**, was not painted on its surface after the bottle itself was finished. A small amount of colouring matter was added to the glass when it was still liquid and as the craftsman blew it into this shape, the colour inside the glass grew with the bottle. The pattern which we see was produced by the same process as the shape of the bottle. If the glassblower had decided to blow it into a different form, the pattern would have changed with the form. The same can be said of the crackle pattern on the pottery bowl, **2**: the pattern is perfectly adjusted to the shape, in fact, the pattern expresses the shape. This is the kind of harmony which a skilful craftsman can achieve between pattern and form, by making use of the natural qualities of the materials he is using. Most man-made patterns, however, exist because of their usefulness, and not for decoration. We have sometimes spoken of honest shapes, shapes which are designed to served their purpose best, and we have discovered that such shapes are usually pleasing. The same can be said of honest patterns. The pattern on the ancient drinking vessel, **3**, was made to prevent it from slipping out of the user's hand. The patterns on the wireless set knobs, **4**, have a similar purpose – to give the operator a better grip. These patterns belong to their shapes because they have something in common; their usefulness. Such combinations of patterns and forms are found on many industrial objects. The giant machine in picture **6** is an accelerator and is used for speeding up electrons in nuclear research. Both the shape and the pattern were designed for the efficient working of the machine, and that is why their unity is perfect. The shape and pattern of the radio valve, **8**, also make one unit of great harmony. Industrial products such as these are not normally thought about in terms of their beauty, but often they give us shapes and patterns which, although they were produced for use rather than appearance, are more beautiful than many man-made things specifically designed to be decorative.



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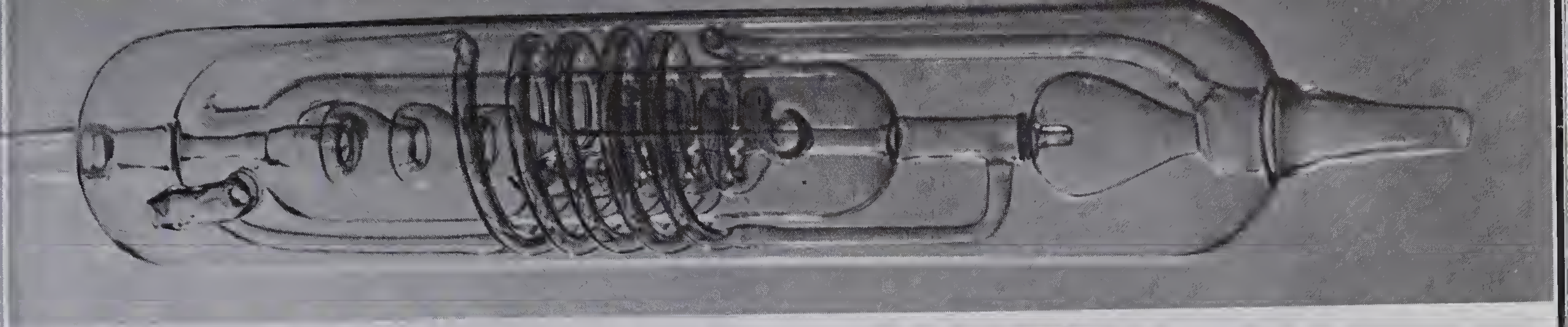

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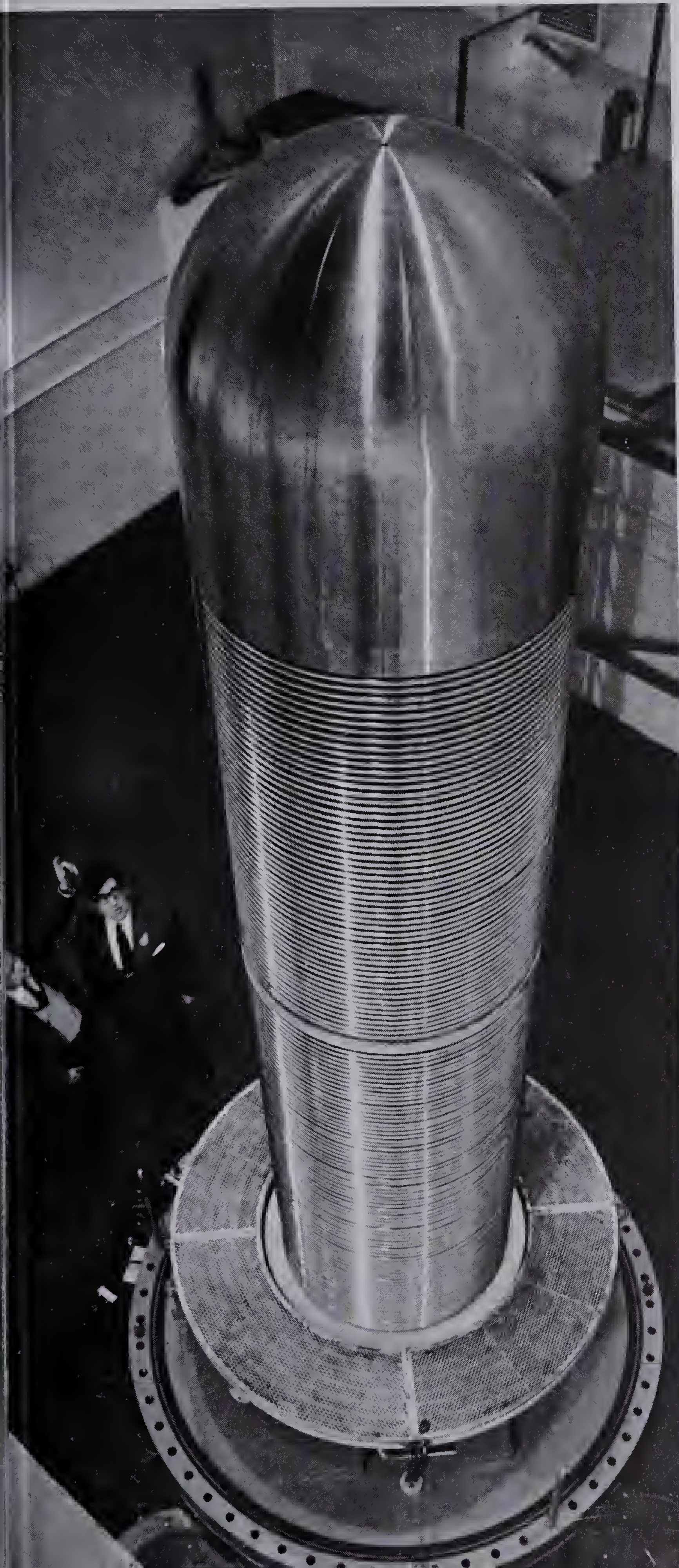

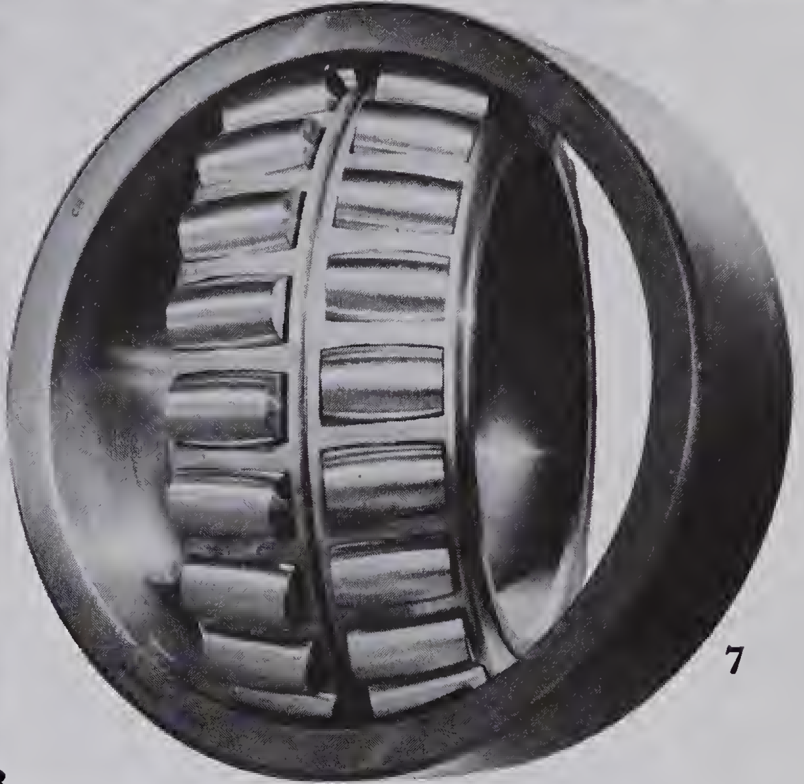

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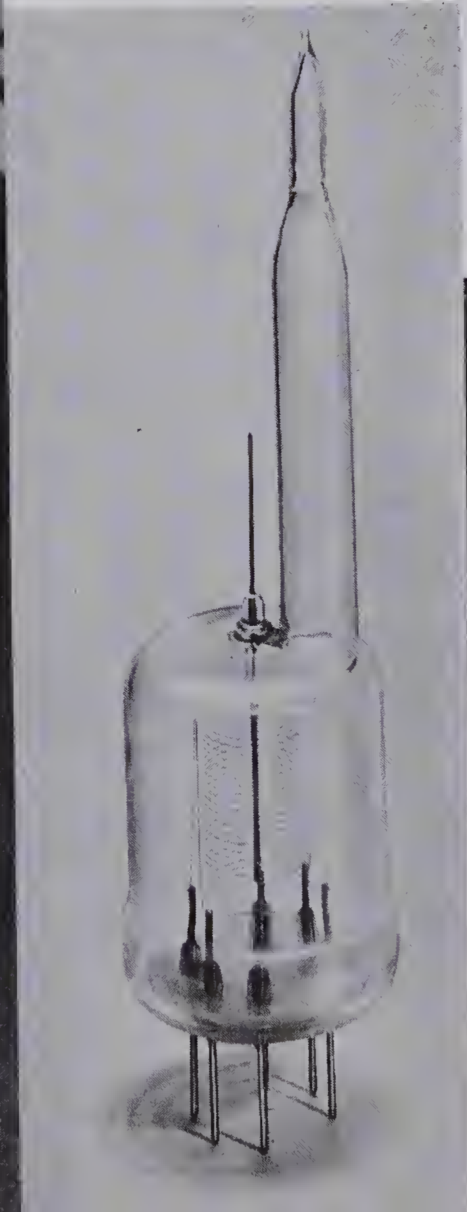
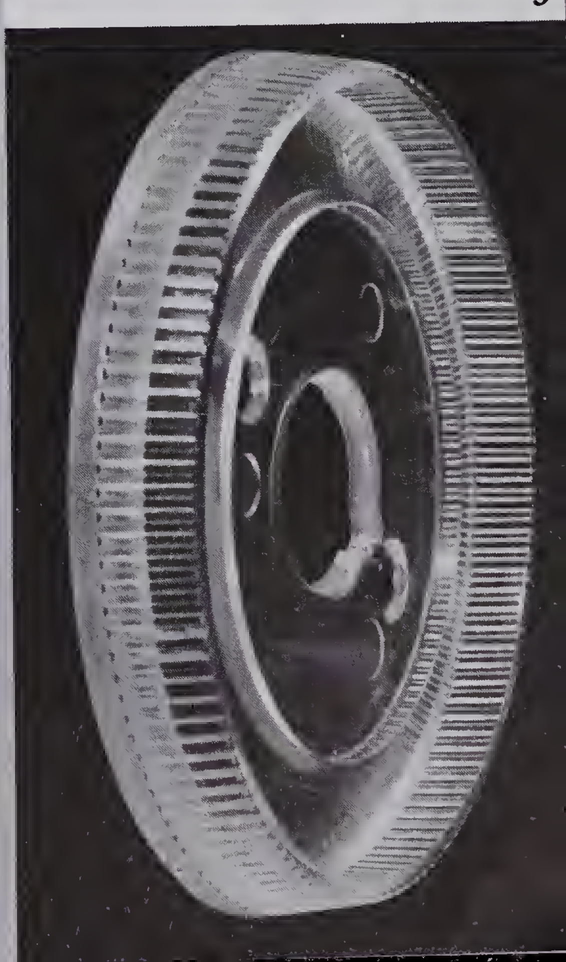
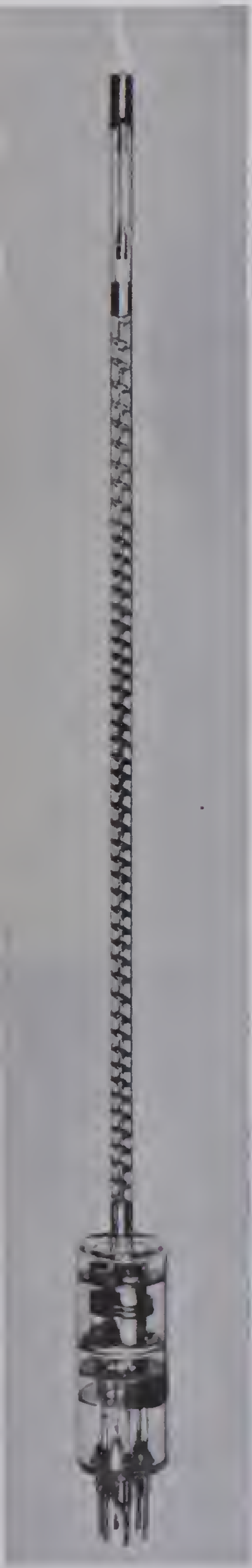


5. *Condenser used in organic chemistry* **7**. *Roller bearing* **9**. *Television channel selector made of polystyrene*

9



There is a wonderful relationship between the pattern and the shape of the radio valve, **1**, *and the model of the new G.P.O. tower in Howland Street, London,* **2**. *In both cases function is the unifying factor.*



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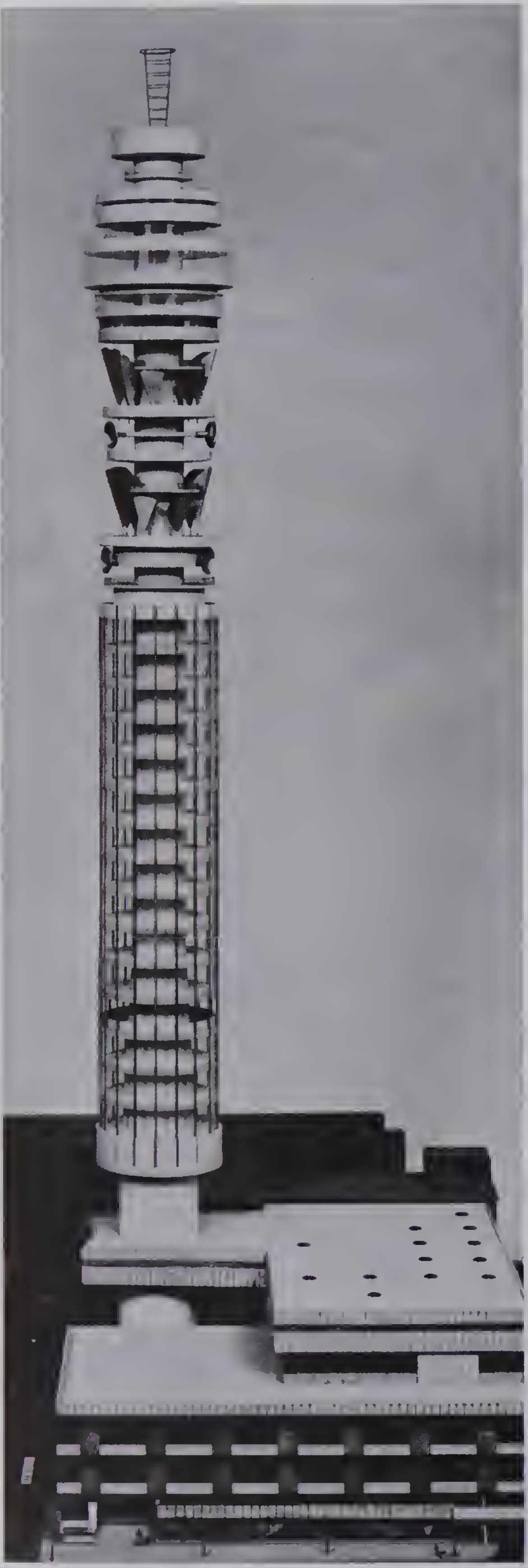

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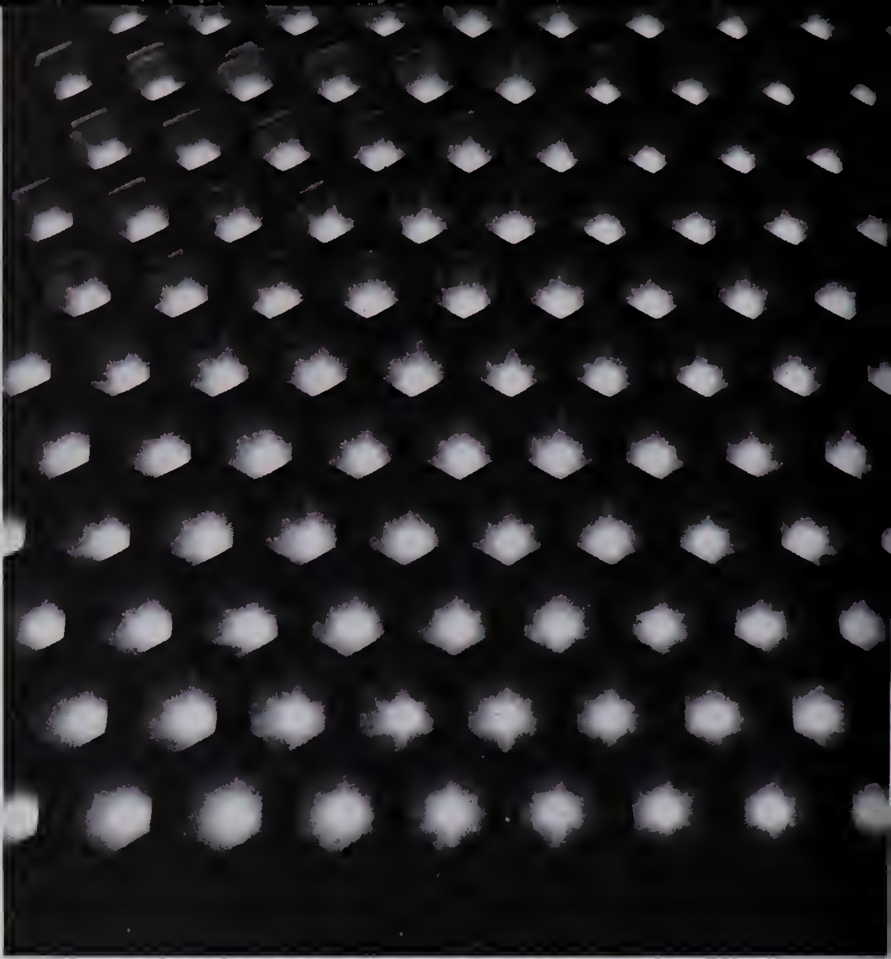
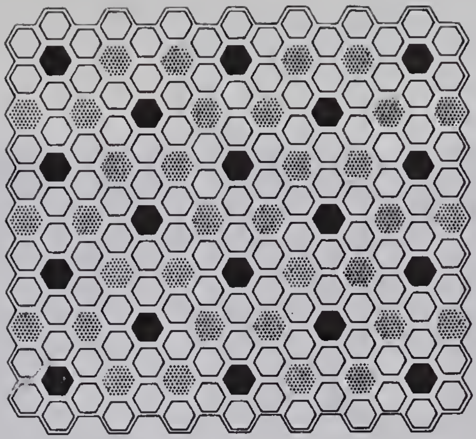


3

4

Picture **7** *is a view of the conference hall of the Trades Union Congress Memorial Building. The various patterns you can see in it are there for usefulness and so form a harmonious decoration similar to the patterns of the industrial objects on page 93. The most interesting of these patterns is the one on the ceiling, and picture* **4** *shows how it comes about. The hexagonal openings are supported at the corners by steel tubes which are joined to long girders. Below each window in the ceiling is a lamp. This arrangement makes it possible for the lighting of this large hall to be evenly spread both by daylight and artificial light. The lights can be switched on in many different patterns,* **5**, **6**, *according to the amount of light needed. The girders also act as rails for blackout material when the hall is used for film shows. These ceiling patterns – all of them useful ones – combine to form one large rich pattern which is perfectly related to the hall and its function. Because this pattern is part of the structure of the building, it can be seen from the outside as well as the inside,* **3**.



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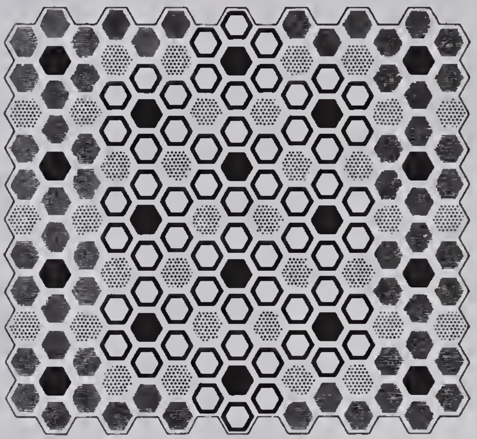

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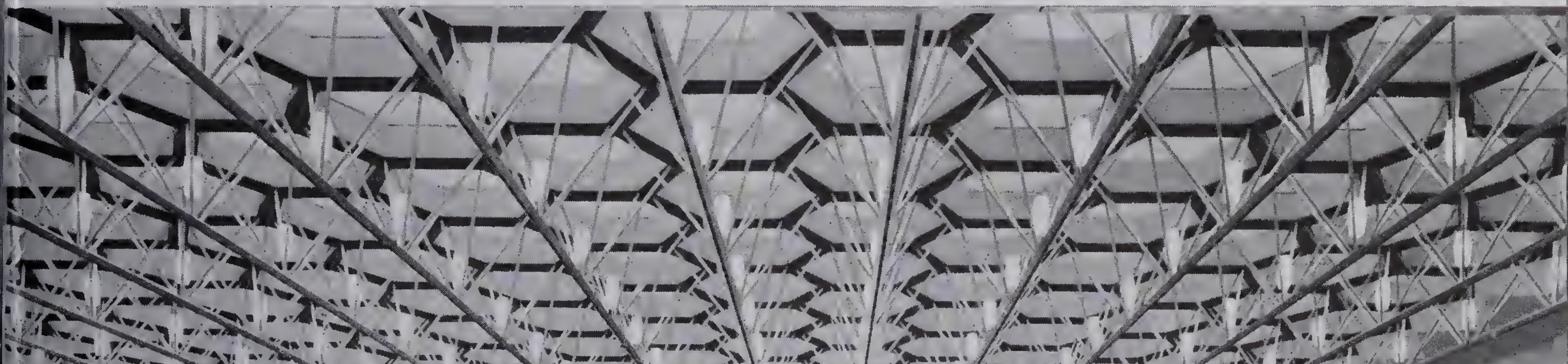
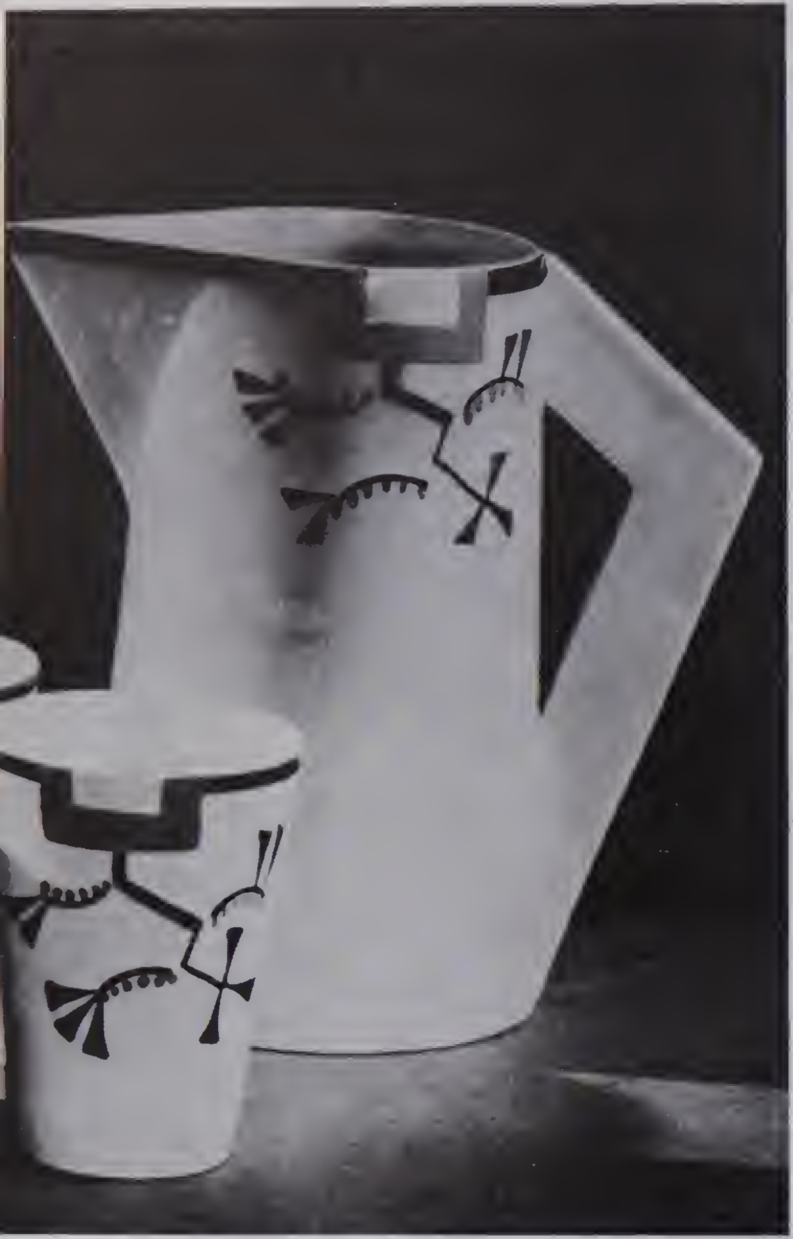


7

1

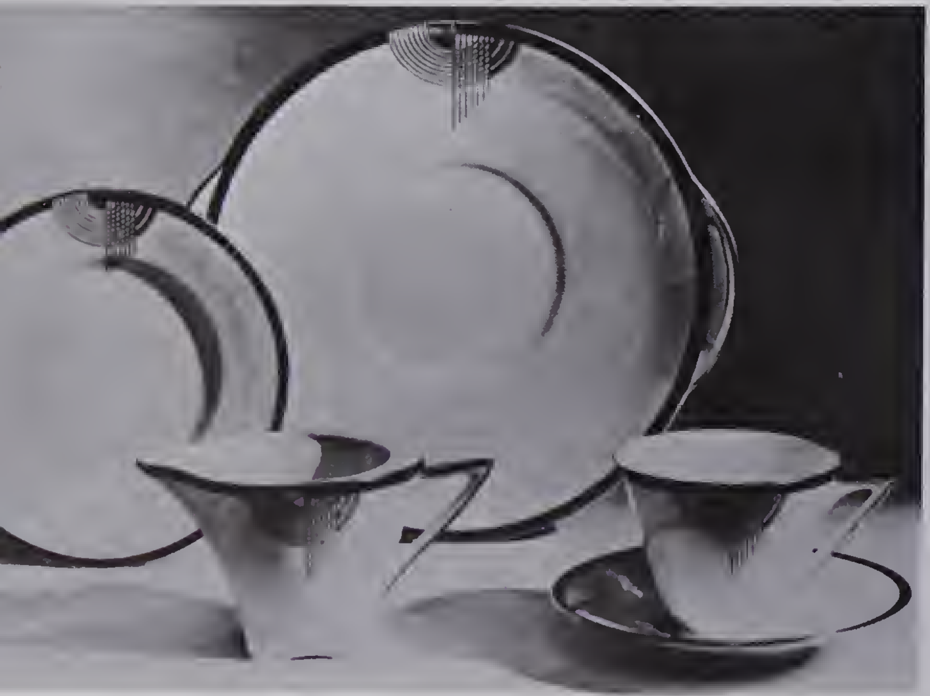


All the man-made shapes we have discussed so far in this chapter are linked with their patterns; they were either produced by the same process, like the glass bottle and its pattern, or they were produced for the same purpose like the shape and pattern of the radio valve. Shapes and patterns with such close links go together easily and therefore please us.

But man-made patterns are not always of this kind. Many are painted, printed, engraved or transferred on to forms which have been produced independently. We have seen how important it is that a pattern should be related to the material; we now see that it must also be at one with the shape. Do you think that shape and pattern are well matched in objects **1**, **2**, and **3**? Does the pattern add to the beauty of the object?

In all these objects there is no relationship between the shape and the pattern which decorates it.

The patterns have nothing at all to do with their forms; they are dishonest. In some cases they may be there only to cover up some fault in the construction, as strips of beading on furniture often do. Although the makers of these objects probably thought that they were improving the appearance of their goods by adding a pattern, in fact they have done just the opposite. These patterns and shapes are not only bad in themselves, but since there is no relationship between form and pattern both will look their worst.



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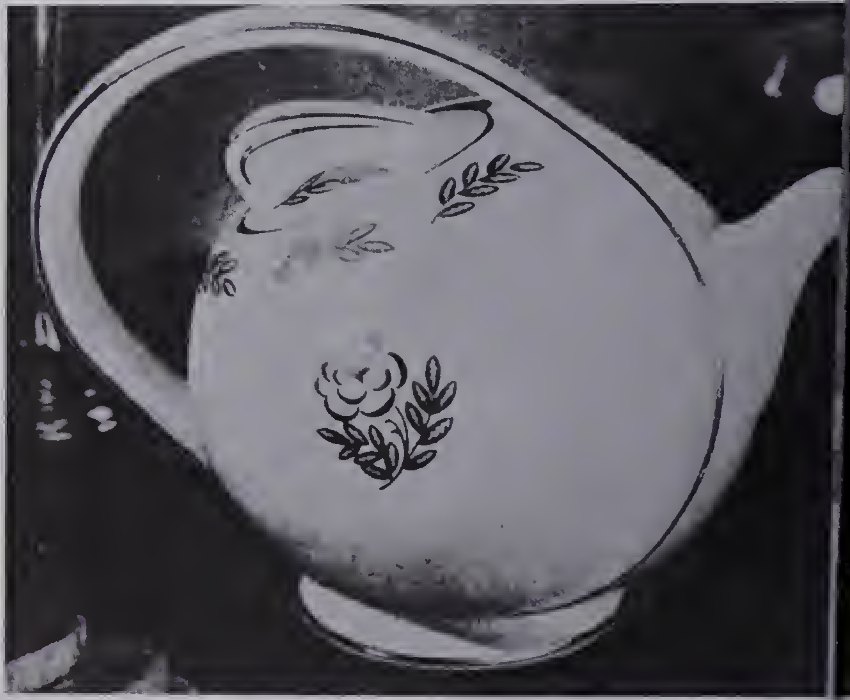

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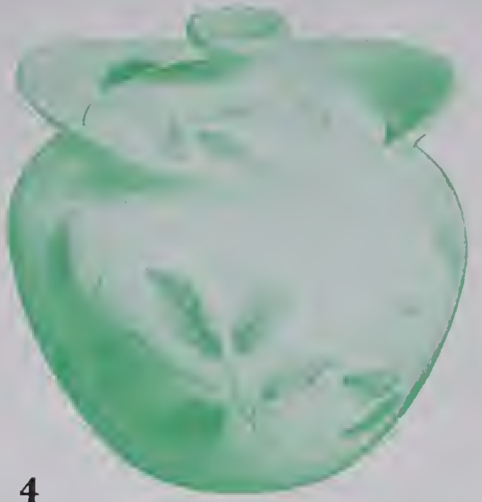
To decorate anything successfully we must find a true relationship between pattern and form like that in natural objects. Without this, no successful decoration is possible. Broadly speaking, the character of the form should be reflected by the pattern. A thin delicate shape, like a china cup, must be decorated with a delicate pattern, while a heavy solid shape should have a heavy pattern. As you can see in pictures **4** to **8** the right pattern will not merely cover the surface of a shape but will enhance the shape itself. If the pattern is really successful it will become so much part of the whole form that, as in the case of the nut, we cannot imagine the one without the other.



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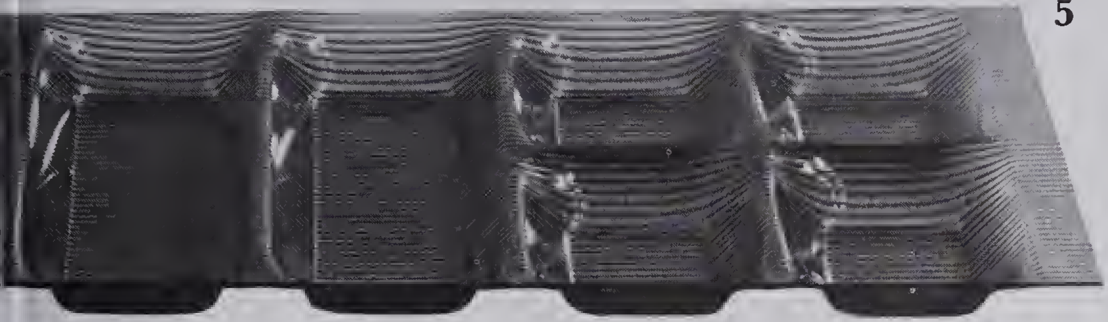

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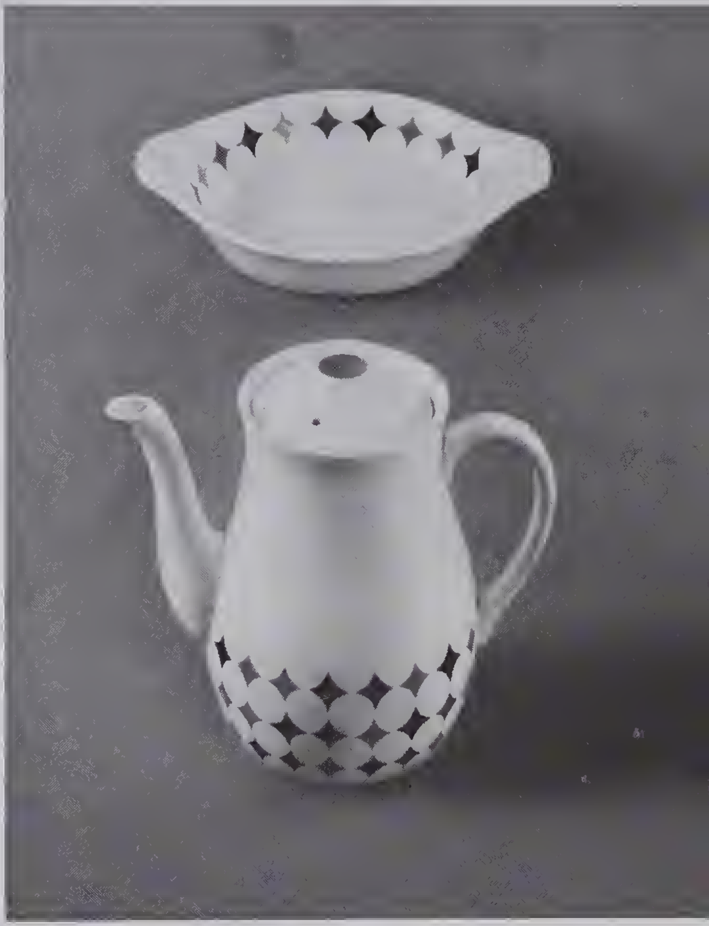
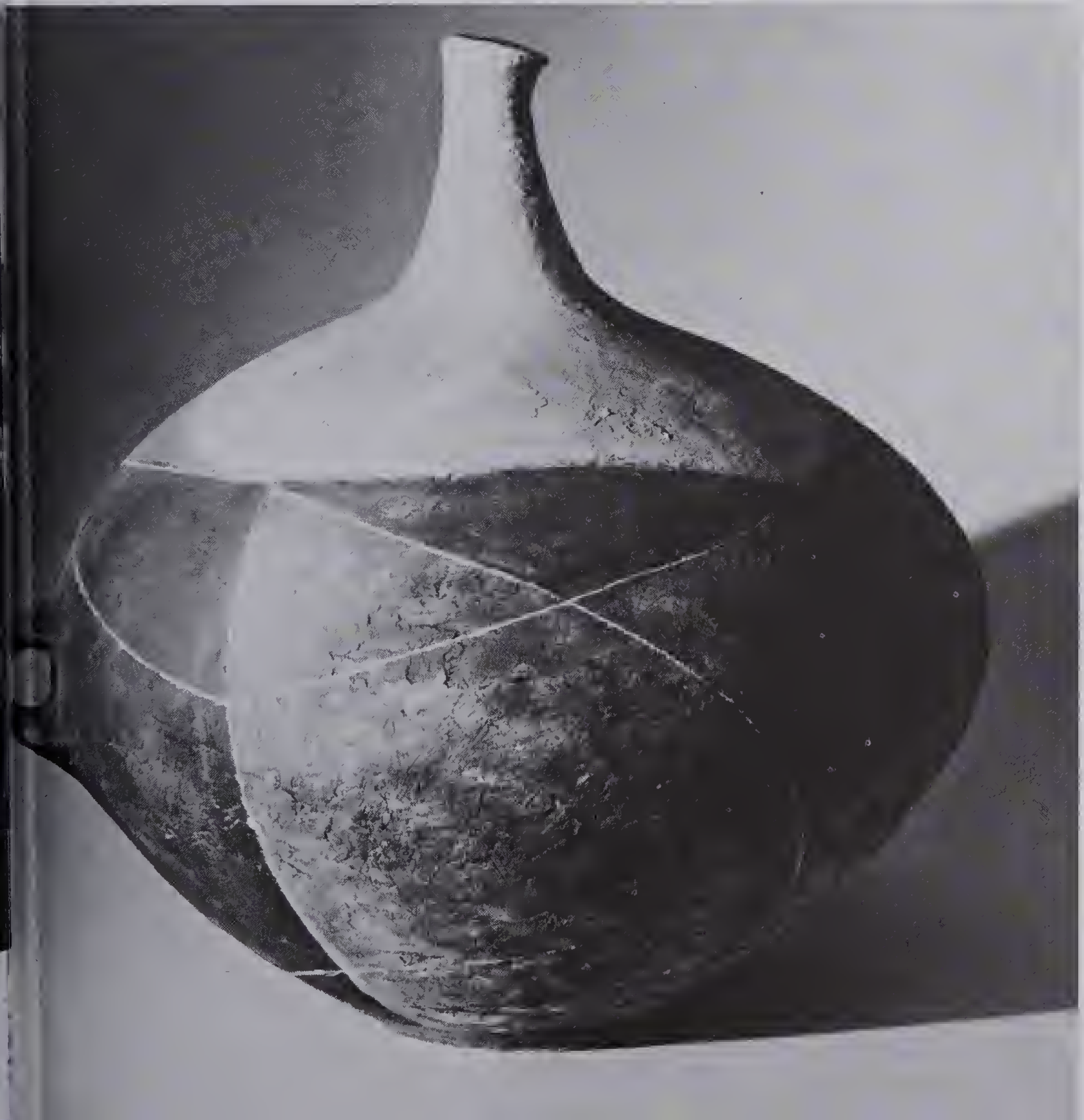


6

Compare the delicate pattern on the china jar, **4**, *with the somewhat bolder pattern on the ovenware,* **6**, *and the simple, unpretentious pattern on the plastic beaker,* **8**. *These patterns seem to have been designed for the materials as well as the shapes. The patterns of the salad dish,* **5**, *and of the pottery bottle,* **7**, *also stress the shapes on which they appear.*



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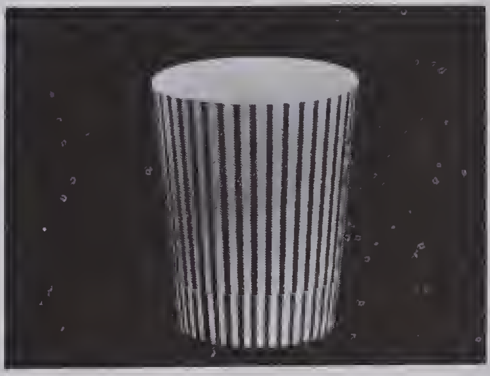

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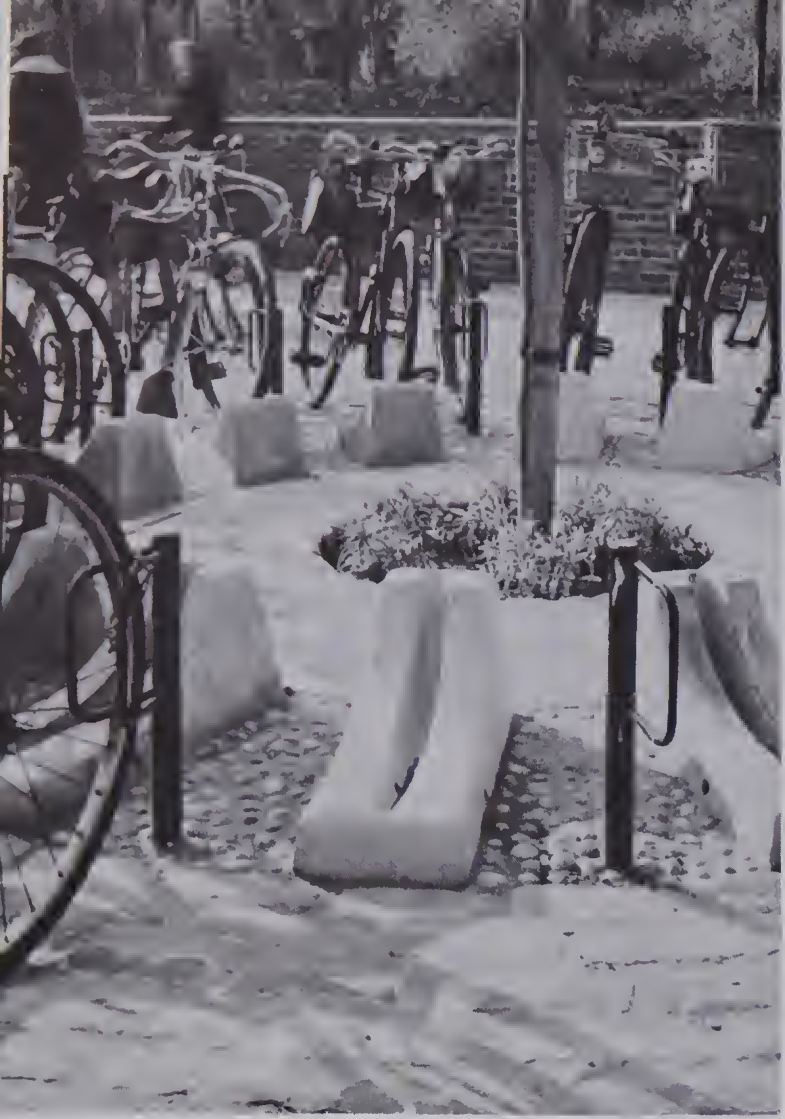
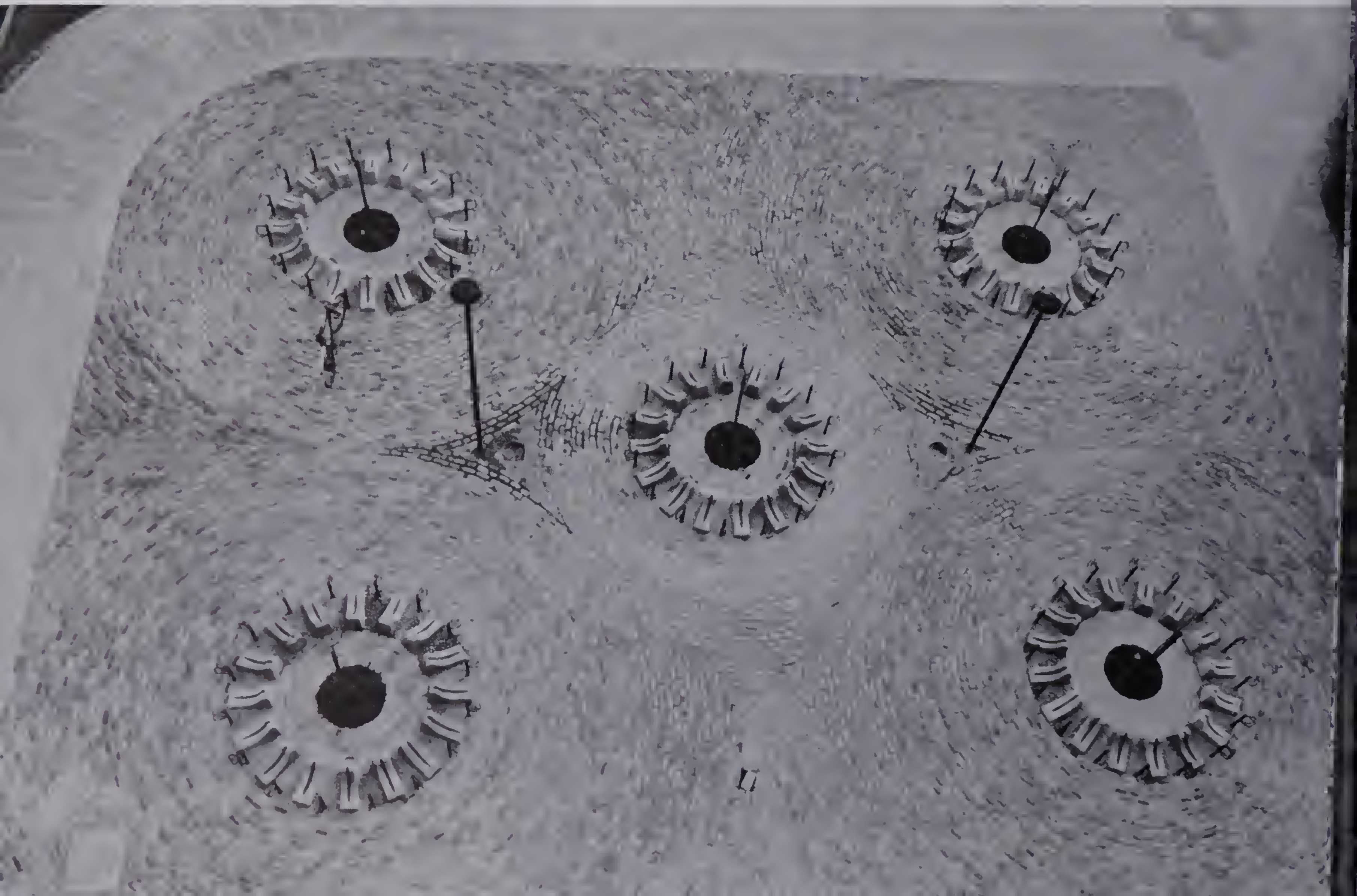


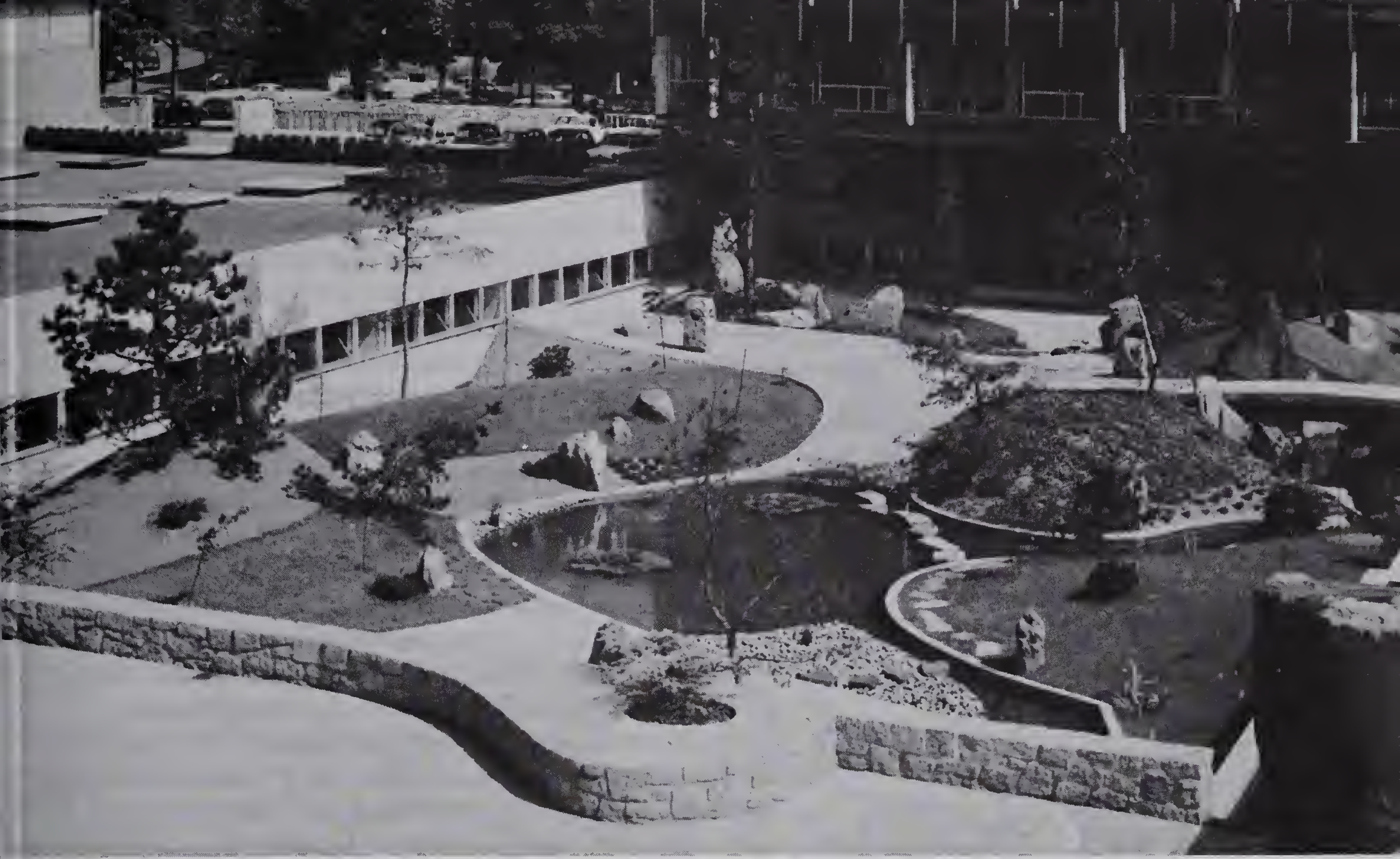
1

There is one particular kind of pattern which should be mentioned. When you look at a paved square you will see the familiar pattern shown in picture 1. But from a distance it will appear less obviously as a pattern. Seen from an aeroplane or a high building it will look like picture 2. The pattern has almost disappeared and what is left is a kind of grain. Patterns which are so small that it is difficult to realise that they are patterns, are called textures. Any pattern may be turned into a texture by looking at it from a great distance; and in the same way, what we normally call a texture may be seen as a pattern by looking at it from close quarters. The difference between a pattern and a texture is only one of size, and sometimes it is difficult to decide which is pattern and which is texture. In nature the two are completely mixed and what we have said about patterns will also apply to textures.

Textures not only enrich patterns but also provide connecting links between contrasting patterns and forms.

2





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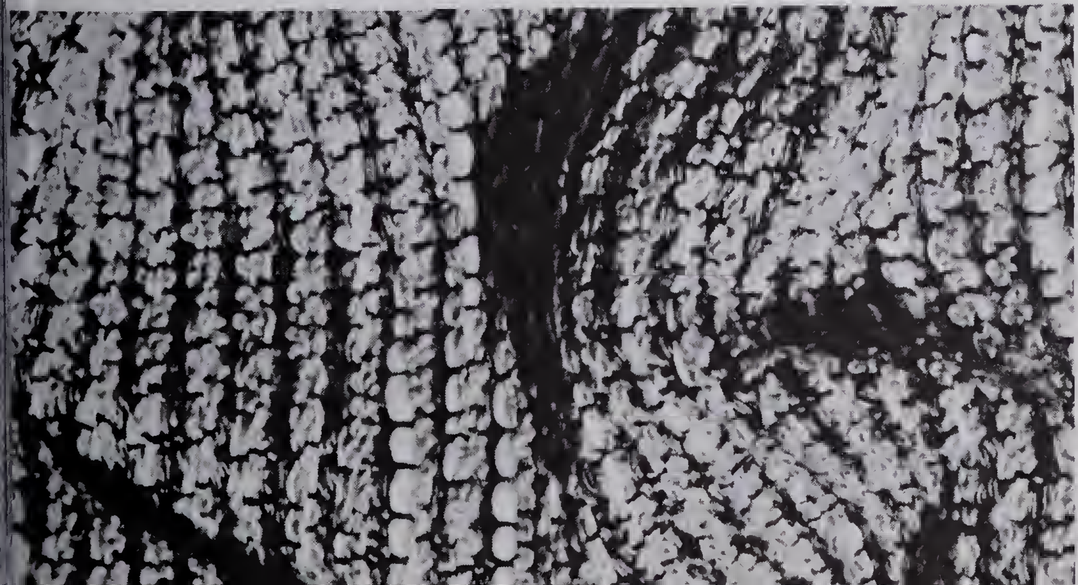
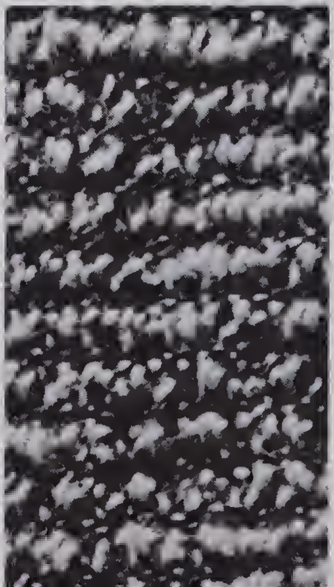
The designer of this garden, **3**, **4**, *round the UNESCO building in Paris used textures to enrich the pattern. Plants and surfaces have been chosen for their textural effect. When we design anything, our own gardens or living rooms, for instance, we should think not only in terms of colour but also of textures. Most people look at colour samples, but how many think of the textures they are using,* **5**, **6** *and* **7**, *and the effect they will give when used together?*

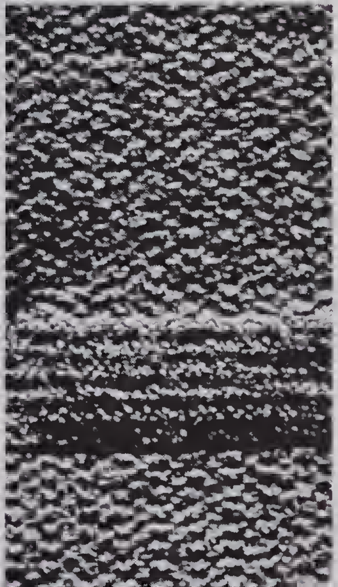
4

5 6

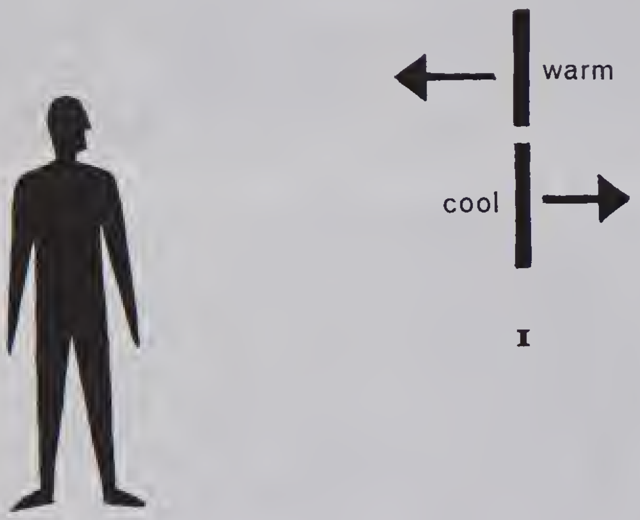
7







1. *A panel painted in a warm colour, such as orange, will appear to be nearer to us than if it were a cool colour, such as blue. In this way we can influence the apparent shape of a room. If the wall shown green in diagram* 2 *were orange, it would make the room appear shorter; if blue, longer.*



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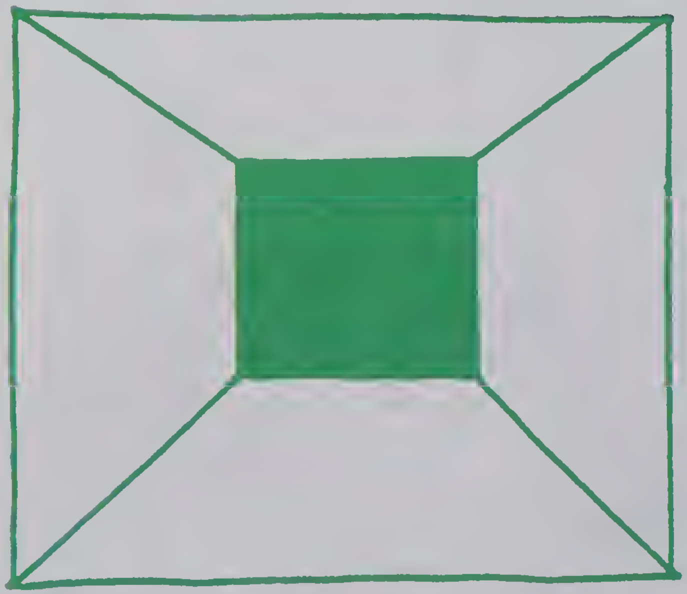

We have been discussing the surface of form and we cannot leave this subject without mentioning colour. If you change the colour of a shape you also change its character and many people would go so far as to say that colour is more important than pattern or texture. There can be no doubt that the colour of an object is a very important part of that object.

You have probably seen a colour circle in which each colour is very close in hue to its two neighbours and is in complete contrast to the colour lying opposite, **A**.* Colours which lie opposite each other are called complementary colours, and there is a strange relationship between them. One of the first men to describe this relationship was the German poet Goethe. He tells how one day he entered a tavern and was served by a girl dressed in bright red. When she had gone he still had a clear visual impression of her shape against the white wall, but the shape now seemed green, not red. Red and green as you can see from **A** are complementary colours. Two such colours seen side by side appear much brighter, **B**, than by themselves, **C**, and the contrast between pure complementaries can even be strong enough to cause physical pain if we look long enough. Neutral colours are therefore necessary to soften what would otherwise be violent effects.

The square, **D**, inside the four rectangles, is the same colour in each case, but it is influenced by the colour of its surroundings. From this it will be clear that the individual colour of an object does not matter so much as the colour relationship between it and its neighbours. Colours can make each other look lighter or darker, warmer or cooler. Whenever we use colours we must bear some of these relationships in mind.

Colours may be compared to adjectives, which mean little by themselves until they are used to describe nouns. For instance the word "long" has no real meaning until we relate it to a noun and then it will change its meaning according to the noun. Compare the expression "a long time" to the expression "a long street" and you will see that the adjective "long" can be made to mean different things.

Colours behave in a somewhat similar way. They have a close relationship with the objects to which they belong. Different foods, for instance, are associated in our minds with different colours. Experiments were carried out with coloured bread, and samples were given to people to taste; they maintained that it had a different flavour from the usual variety. The colouring matter was in fact quite tasteless. Bad lighting can distort natural colours and when food is seen in such light we may lose our appetites. Green meat or red soup may nauseate us, while the same colours may please us in a fabric or in a landscape.

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*Letters in heavy type refer to illustrations on the front endpaper.

In some old towns and villages local building materials are still widely used instead of materials brought from other parts of the country. The people of such places must have been using the same or similar materials for centuries. To them the natural colours of stone, wood, bricks, plaster and tiles are unchanging and cannot be thought of differently. When new buildings are added in such towns or villages, even when they are built of modern materials, an attempt is made to colour them like existing older buildings. This is not so much to make them fit in with the rest of the street, but because people of the district prefer their houses in this particular colour, just as we prefer our bread to be of one particular colour and no other.

Man is influenced in all he does by his surroundings. Not only his patterns and forms but also the colours he chooses will be deeply affected by the background in which he lives and in which he grew up. This is why people in one part of the world use colour in a different way from people in another part of the world.

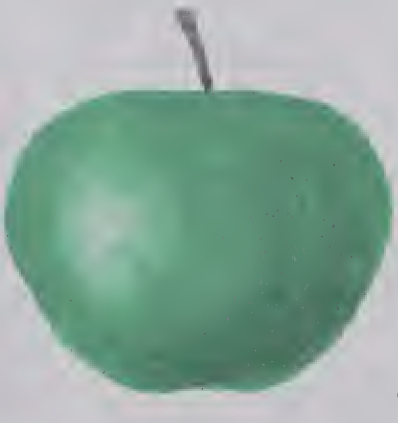
If you look at almost any shape you will see that the colour changes according to the kind and amount of light which each part receives. If an object is lit up by very strong light, the lightest and the darkest parts will appear to have the least colour in them, while the part in between will seem to be brightest, **5**. Too much light or too little light will reduce the intensity of a colour. What applies to a single object also applies on a larger scale, even to whole countries.

In countries with bright sunlight, for instance in Italy, colours seem less bright than in England. That is why brighter colours are used in Italy. If objects made there are brought to England they seem very much

3

4

3, 4. *Two houses in an Italian town*
Although belonging to different periods and therefore constructed in different ways, both are coated in the local orange-yellow plaster. The whole town has a harmonious appearance.



5

brighter here than they did in Italy. If an object made in England is taken to Italy it seems quite dull there. We know that different parts of the world and sometimes even different parts of the same country produce varying patterns and forms, and that these patterns and forms express the character of the region. This character also expresses itself in colour. The natural surroundings create a certain combination of colours and the light makes some adjustments to the appearance of these colours. The combination of colours characteristic of a particular region can sometimes still be seen in man-made things from that region, although there are not now many places left where people still have their native instinct for colour. Nowadays good communications carry cheap materials – often better than the local ones – to all parts of the world. Unfamiliar materials, patterns, shapes and colours are therefore making their appearance even in the most remote places and people's instinctive understanding of their own background is disturbed. In the end this understanding may be entirely lost. This is an unfortunate result of the interchange of goods and ideas made possible by our machine civilisation. What people used to do by instinct must now largely be done by reasoning. The materials, patterns, shapes and colours from the same earth, the same climate and the same background are subtly related to one another. Now that we are not so closely identified with one particular background, we cannot preserve these relationships, but we can substitute others for them. When an artist paints a picture and places colours next to each other, he is searching for relationships between them. If the pattern of a picture is made up of disconnected bits and pieces, if there is no relationship between the various parts, it will not make sense. If there is no relationship between the various colours, it will not make sense either. We have observed these relationships in all natural forms, including landscapes, and also in man-made things. The artist does not try to imitate or copy the shapes or colours he sees, but he must try to find relationships between them.

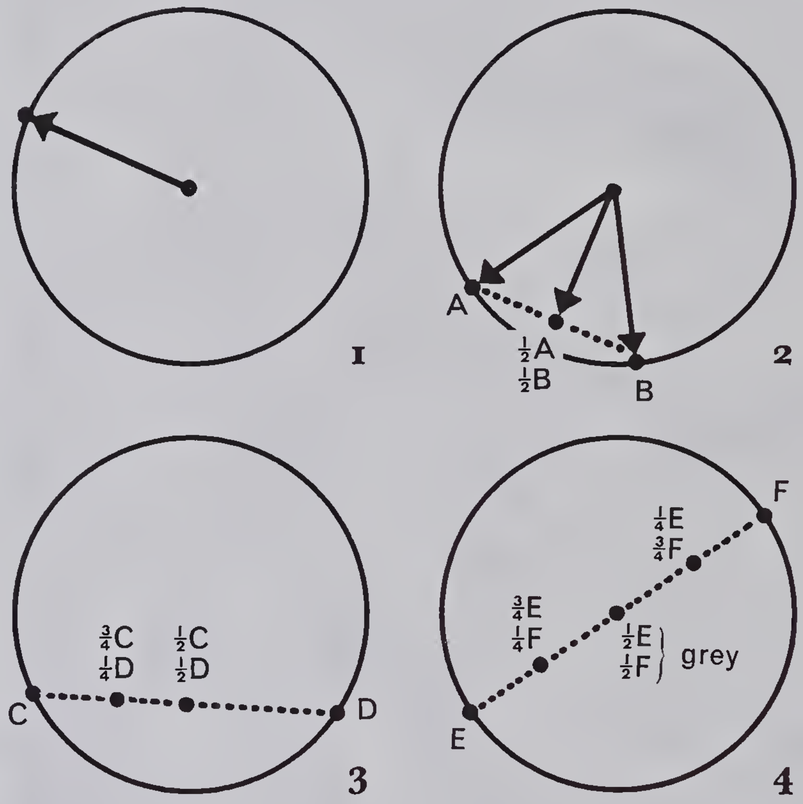
Only colours which are bound to each other by a

The colours this artist is using will add a further relationship to the one already existing between the shape of the vase and the pattern decorating it.

relationship will be harmonious. In achieving this the artist is greatly helped by the simple process of mixing colours. Let us go back to our colour circle, **A**. If you mix yellow with blue, you create a third colour, green. But you will never achieve the bright, pure green of the colour circle. The diagrams, **1** to **4**, show why this is so. You can draw a straight line between any two hues and their mixtures will be found on this line. If the mixture consists of the two colours in equal quantity, a true fifty-fifty mixture, then the new colour will lie exactly in the middle of the line connecting the two parent colours. If more is used of one colour than of the other, the new colour will be nearer to this colour. The farther apart the two colours are on the colour circle the more subdued the mixed colour must be, because it will be closer to the centre of the circle, which is grey. If you mix two colours which lie on opposite sides of the colour circle, the result will be grey. You can make a number of experiments to show that grey can be mixed from any pair of complementary colours. It may not work in each case because our colours are not always as pure as they should be and the mixture may turn out to be on the brownish side.

A mixed colour bears a relationship to each of its parent colours, so that mixing colours helps to create combinations of colours which are all in a relationship to each other. If we were to use all the brightest colours we could get, in the same pattern or picture, they would all fight with each other because they would all have the same intensity. But if only a small number of bright colours is used, and the rest obtained by mixing these colours with each other, a series of relationships will come about, and these will add up to a harmonious combination of colours. The artists of the past had comparatively few colours which they could use, but this was no disadvantage. Modern chemistry has given us colours of such intensity and variety as would make the old masters gasp, if they could see them. Even so, painters do not use all the hundreds of colours now available to them. To make a harmonious picture they must take account of the colour relationships we have been discussing. Most great paintings have few very bright colours, held

The colour circle on the endpaper shows all the colours gradually getting duller towards the centre, which is mid-grey, so that in diagram **1** *the arrow indicates the brightness or intensity of a colour. Diagram* **2** *shows what happens when two colours are mixed in equal amounts. The resultant colour, lying half way between the two original colours, is nearer the centre of the colour circle and has a lower intensity. From this it follows that the farther apart on the colour circle the first two colours are, the nearer their mixtures will be to the centre and the duller they will be,* **3**. *Complementary colours in a fifty-fifty mixture will produce grey,* **4**. *But if the mixture contains more of one colour than of the other, the new colour will appear brighter.*



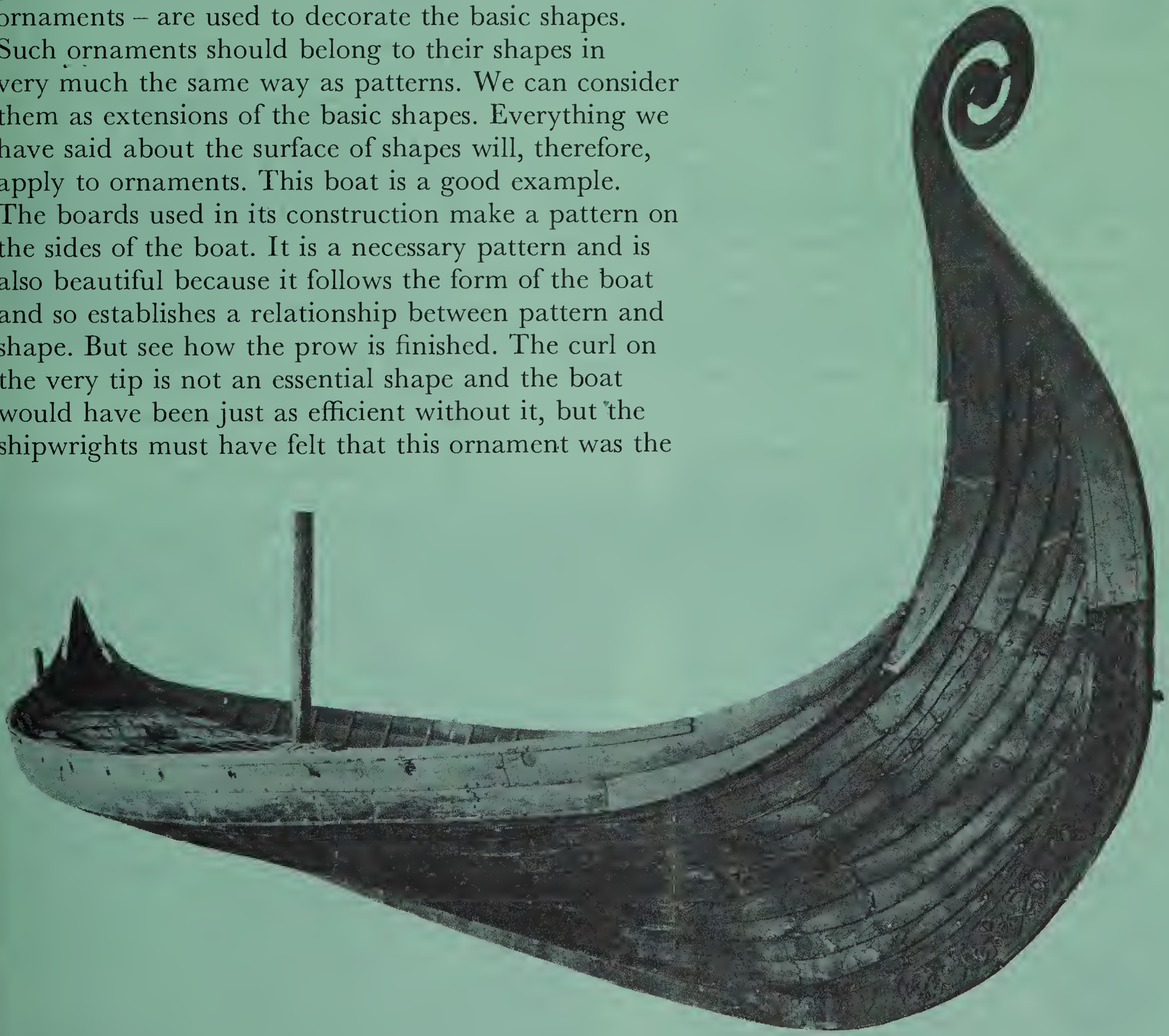
together by other, less intense colours, largely obtained by mixing.

The brightest and cleanest colours of all are the colours of stained glass. The art of stained glass could not come into its own until the science of glass making had been mastered by the craftsmen of medieval Europe, and until the builders of churches and other large buildings had learnt how to reinforce their walls so that large spaces could be left for windows. In such a window the pieces of coloured glass are held together by strips of lead. This could, of course, be a drawback but in the hands of a skilled craftsman and designer the network of strips of lead actually adds a certain quality to these glass pictures. In the best stained glass designs the pattern of the strips of lead is added to the pattern of the picture itself in such a way that it supports and enriches it. Only a person with a deep understanding of the materials he uses can produce designs like these. The pattern of strips of lead also serves another purpose. Because the colours of stained glass are so unusually bright, some of them would tend to clash if there were not a neutral colour to separate them. The pattern of strips of lead provides this neutral colour over the whole picture.

We have noticed that in the past people produced bad shapes and ugly patterns less frequently than they do now. Because they had a deep understanding of their materials and methods, they were more likely to produce good shapes and patterns than bad ones. Today we are more easily disposed to produce bad shapes and patterns because we have such a vast range of materials and methods to choose from. The same is true of the colours we use. Today we have available all the colours of the spectrum, in almost any material we choose, and yet, because they are often more harmonious than those we devise, we constantly go back to the "traditional" colour combinations, which were in use hundreds and even thousands of years ago. But just the same, because we have so many colours to choose from we too often produce ugly combinations of colours, and many everyday objects are manufactured in colours chosen without any consideration for the relationship of the colours to the objects.

Whenever we use colour – and that may mean anything from buying a new dish to painting our houses, we must consider that we are adding yet another set of relationships to our world. If the colour of a shape is not in keeping with the character of the shape, or its pattern, or its material, it will look wrong no matter how much we like it as a colour. We must also consider relationships between the colours of different objects which are in use together. Only when all these relationships – and a few more! – are right will the result of our efforts be entirely satisfactory. The endpapers at the back of this book show how the principles we have been discussing may be applied to actual objects.

Not all decoration of man-made shapes consists of patterns, textures and colours. Sometimes new forms – ornaments – are used to decorate the basic shapes. Such ornaments should belong to their shapes in very much the same way as patterns. We can consider them as extensions of the basic shapes. Everything we have said about the surface of shapes will, therefore, apply to ornaments. This boat is a good example. The boards used in its construction make a pattern on the sides of the boat. It is a necessary pattern and is also beautiful because it follows the form of the boat and so establishes a relationship between pattern and shape. But see how the prow is finished. The curl on the very tip is not an essential shape and the boat would have been just as efficient without it, but the shipwrights must have felt that this ornament was the



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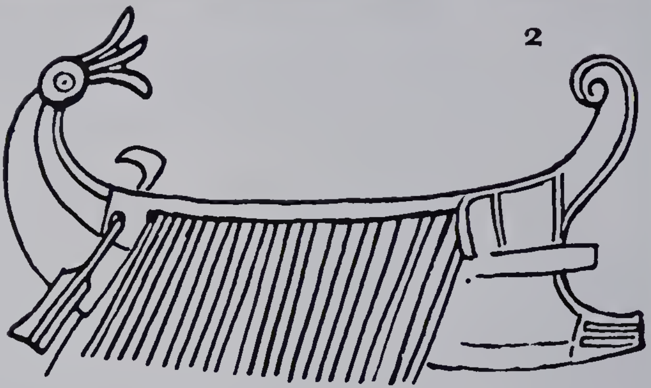
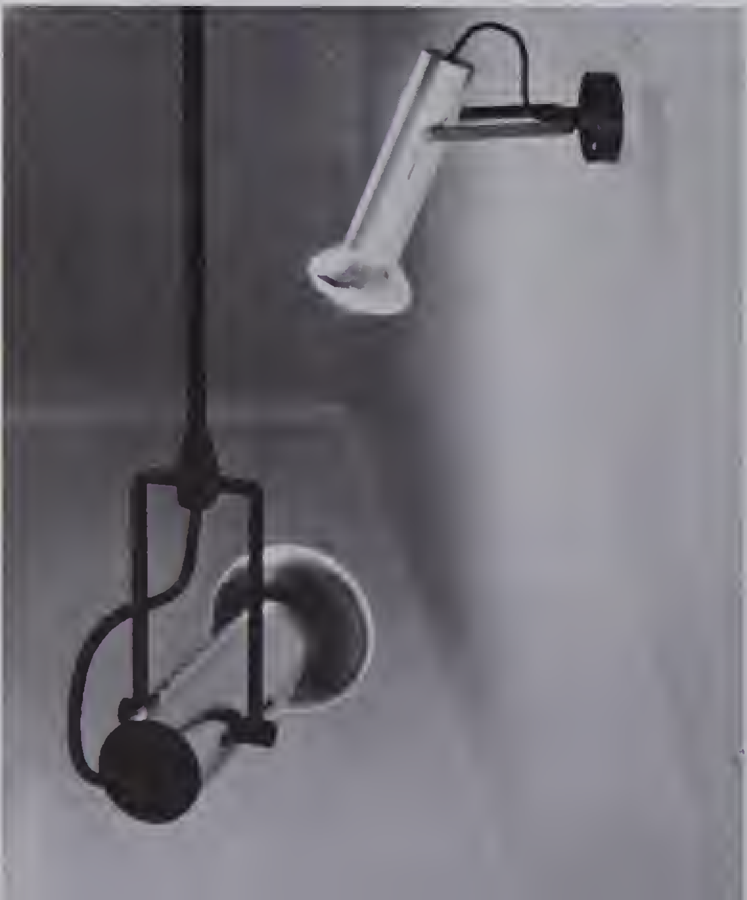
right way to finish the prow. Now people have different ideas about ornaments, and pictures **1** and **2** show that there are, indeed, other ways of finishing a prow. But in one respect all these shapes are the same: they seem to flow from or grow out of the main shape. None of these ornaments was stuck on as an afterthought; they are a natural way of finishing the main shape. Because of this there is no conflict between the main shape and the ornament. When we look at one of these boats there can be no doubt in our minds as to which is the most important shape. The form of each boat is complete and unspoilt. This is the test of a good ornament; that, like a good pattern it should enhance the basic shape, and not distort or hide it.

2



1. *Venetian gondolas*
2. *A Roman trireme*

Ornaments do not as a rule look happy on objects of our own day. The working parts of the lamp **3**, *are completely exposed and unadorned. They have assumed a decorative quality and have taken the place of ornaments. Compare this to the lamp on page 73.*



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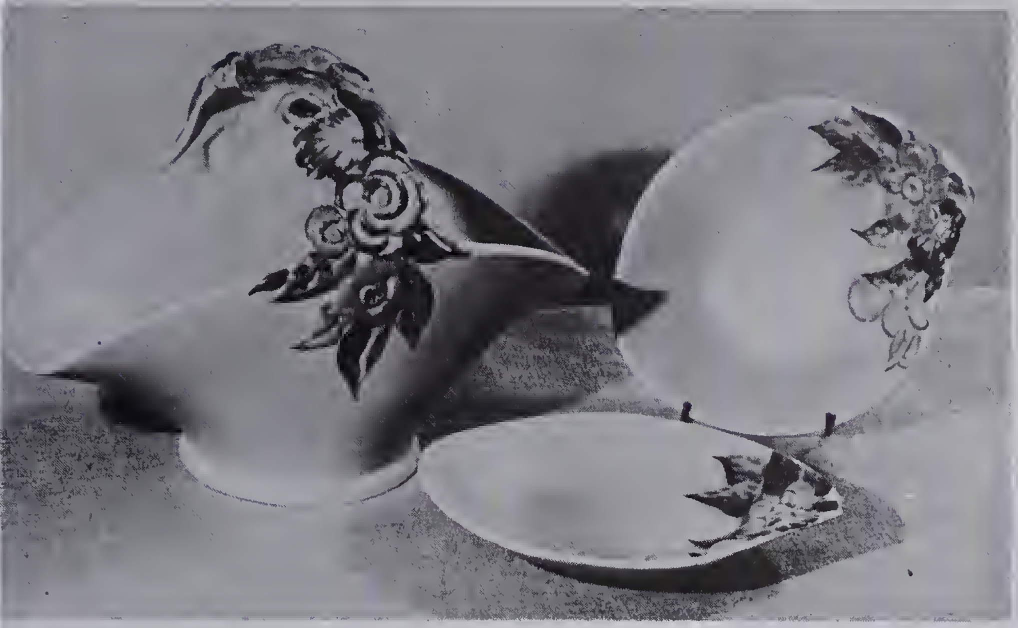

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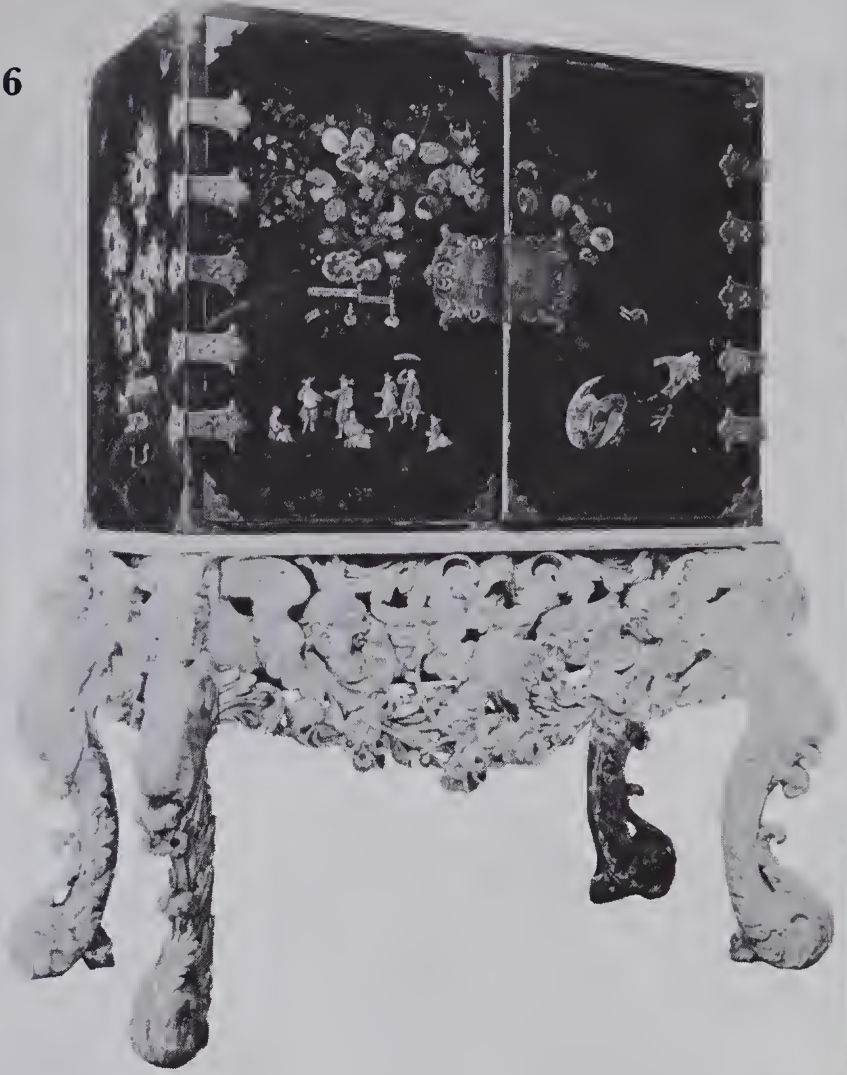
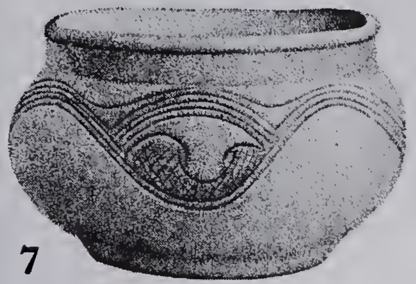


Do you think the ornaments on the fruit bowl and the fruit plates, **5**, *improve their shapes? Are they in keeping with the material? One cannot help but feel that they were inspired by millinery rather than pottery. The ornaments and patterns of the cabinet,* **6**, *are far too heavy. The maker seems to have been more interested in the ornaments than in the cabinet itself.*



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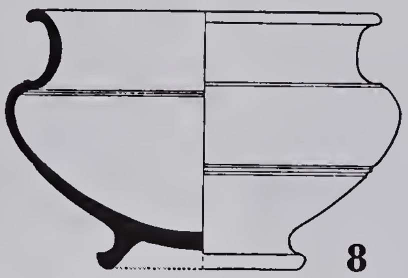

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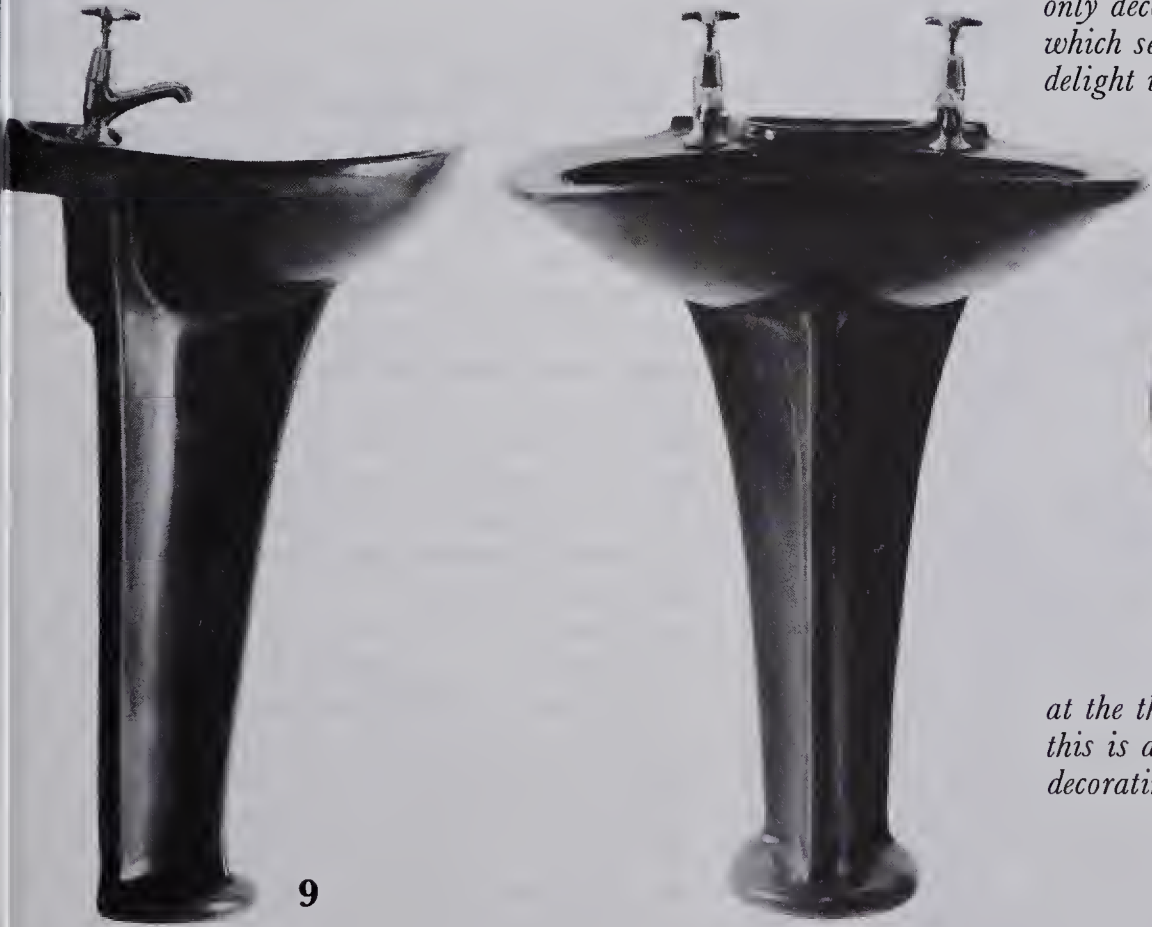
When people take a great interest in the shapes they often pay little attention to decoration. The early pottery bowl, **7**, *from Glastonbury Lake Village was built up from strips of clay and its simple unrefined shape is decorated. The later bowl,* **8**, *also from Glastonbury, was thrown on the potter's wheel, which made it possible to create more elegant shapes than by the earlier method. Notice the harmonious curves and the gently out-turned rim. The only decoration on this bowl is the two simple bands which seem to stress the shape. Because the potter took delight in his shapes he did not wish to cover them. Look at the three views of the wash basin,* **9**. *Do you think this is a good shape? Could anything be gained by decorating it? How does this wash basin compare to* **4**?



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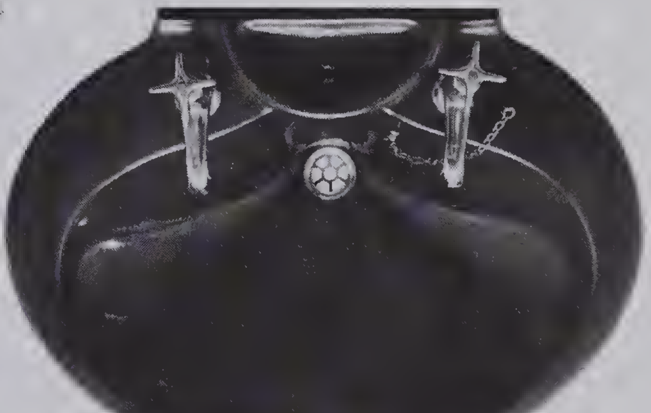
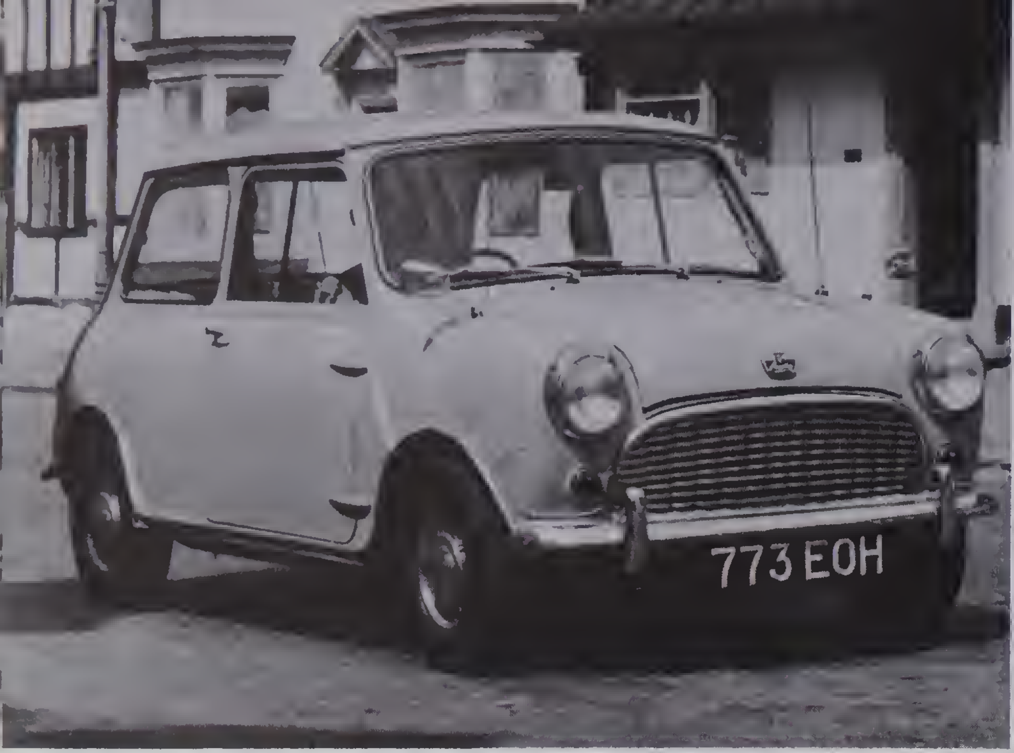
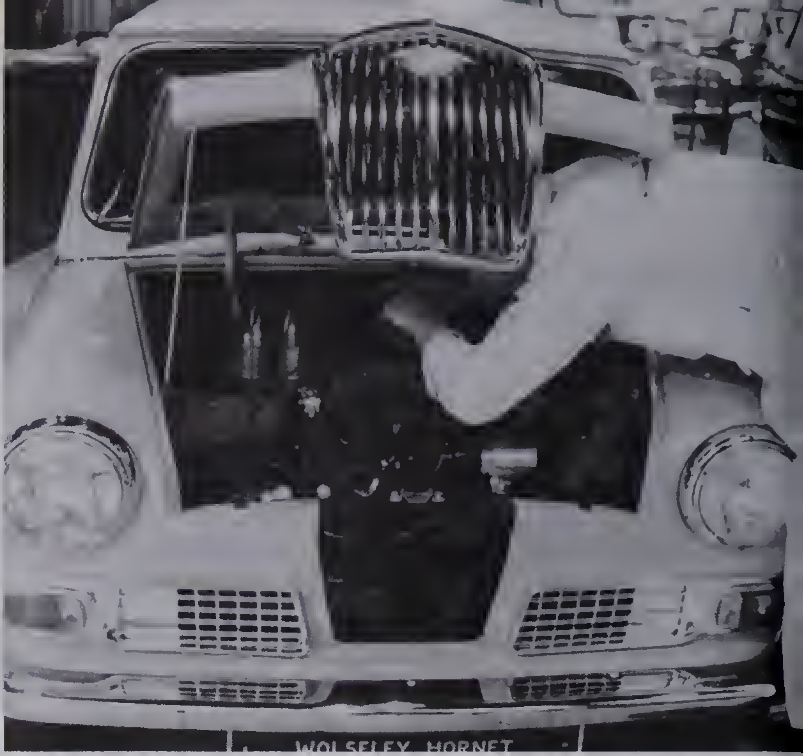
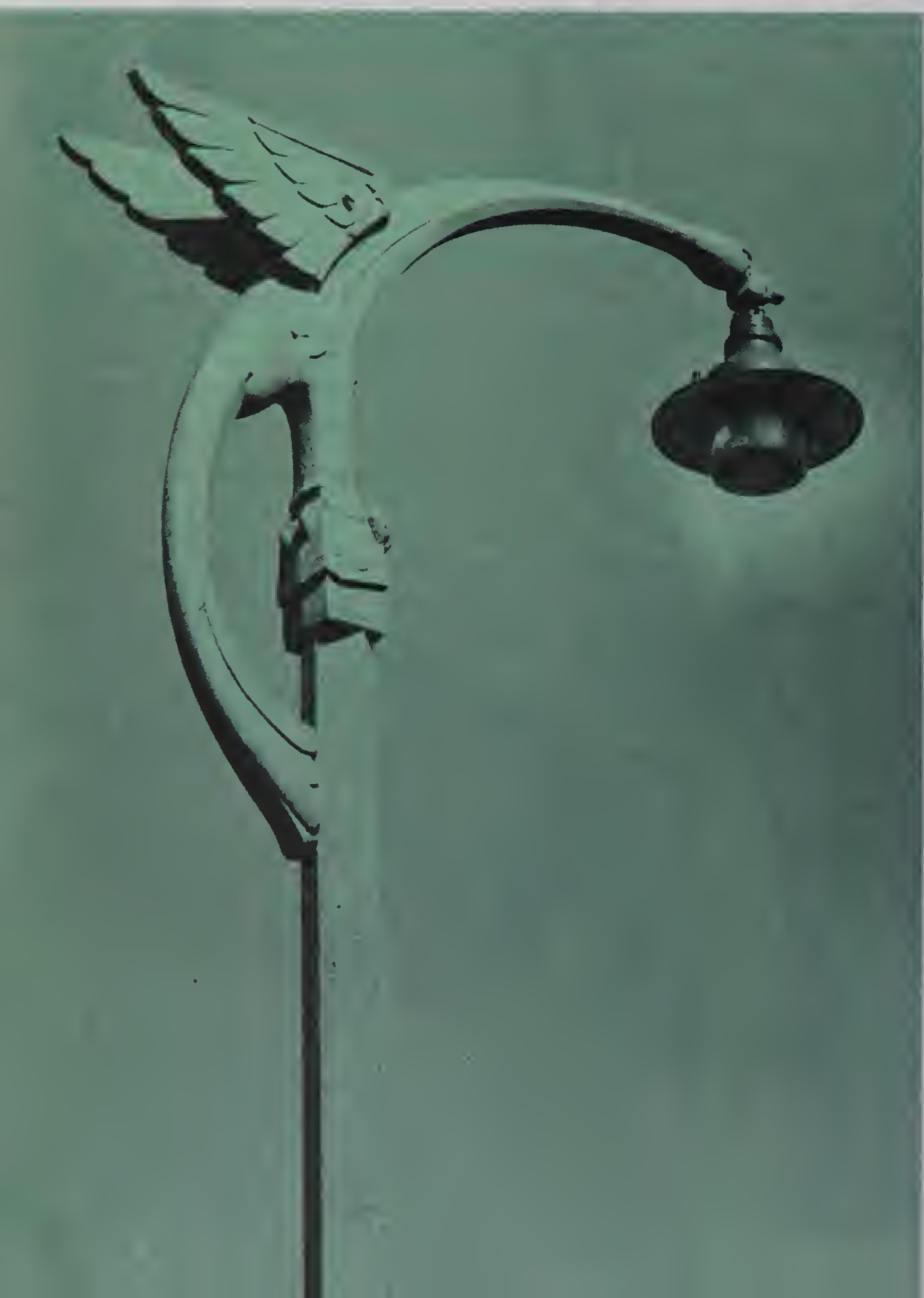






1 **2**



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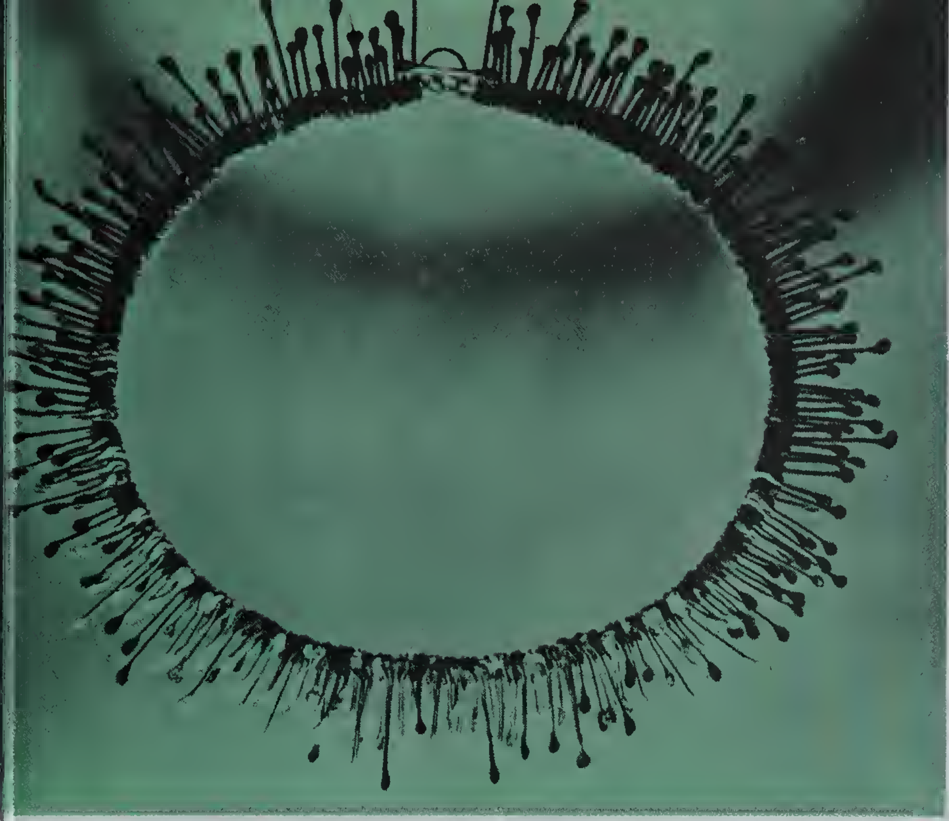
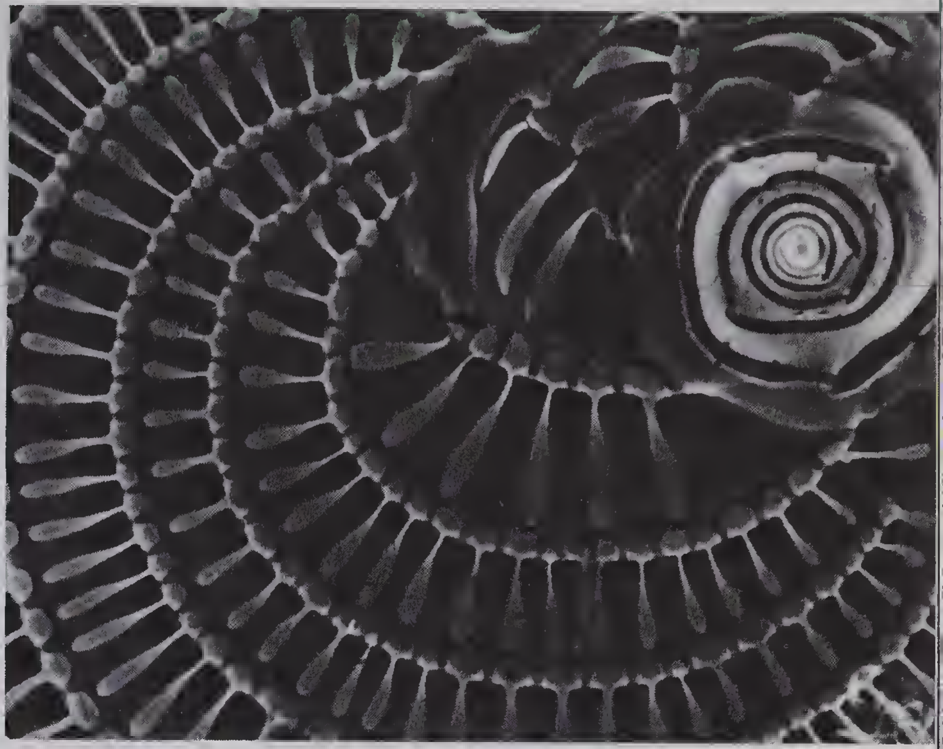
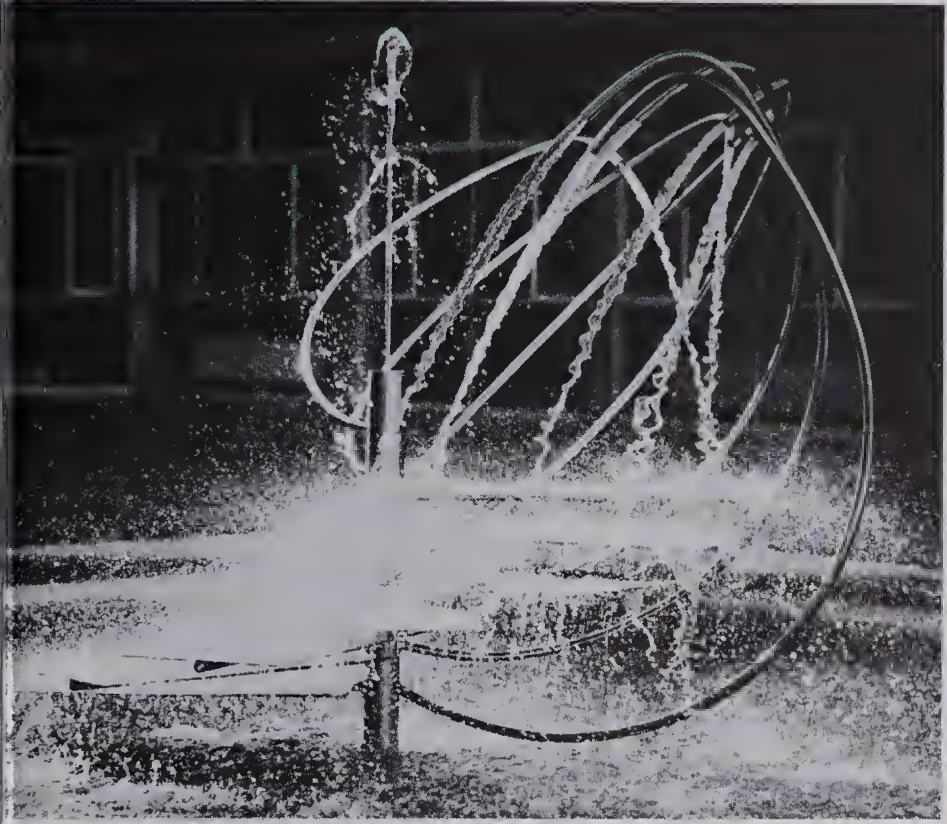
The small car, **1**, *is an excellent design for a small vehicle and combines many advantages. As with many good designs, it would be difficult to think of ways in which it could be improved. Another model of this car was given a radiator grille directly derived from a much older car whose body was built on a different principle. The effect of this modification can be clearly seen in picture* **2**. *As an ornament it disturbs the unity of the shape and is out of keeping with the car's character. From the practical point of view it disturbs the car's functioning, as it is more difficult to get at the engine when the bonnet is raised.*

In a similar way the ornaments on this concrete lamp post, **3**, *add something which is out of character. The designer was intent on giving the impression of a swan rather than a lamp post. Compare this lamp post with the elegant lines of lamp post* **3** *on page 40. Do you think the addition of such ornaments improves the shapes they are meant to embellish?*

4 5







We saw in Part One that the patterns we make often originate in our surroundings, and this is true also of ornaments, whether like the necklace, **4**, *they are complete in themselves, or whether they decorate other objects. The necklace, designed quite recently, has an unusual shape. It may not have been directly derived from photographs like that of the spiral fossilised animal,* **5**, *but in an age in which such natural patterns are familiar we must expect man-made patterns to be influenced by them.*
Both these fountains, **6**, **7**, *rely for their effect on the natural qualities of water, on gravitation, and on mechanical efficiency. The first achieves a decorative effect of pure joy. The second appeals to our minds as well as to our emotions, for we can watch each aluminium dish fill up and overturn through the weight of the water, setting off a series of other movements. Both fountains are designed with a scientific perfection which makes these effects possible. They are ornaments which seem to express an age in which science plays a very important part.*

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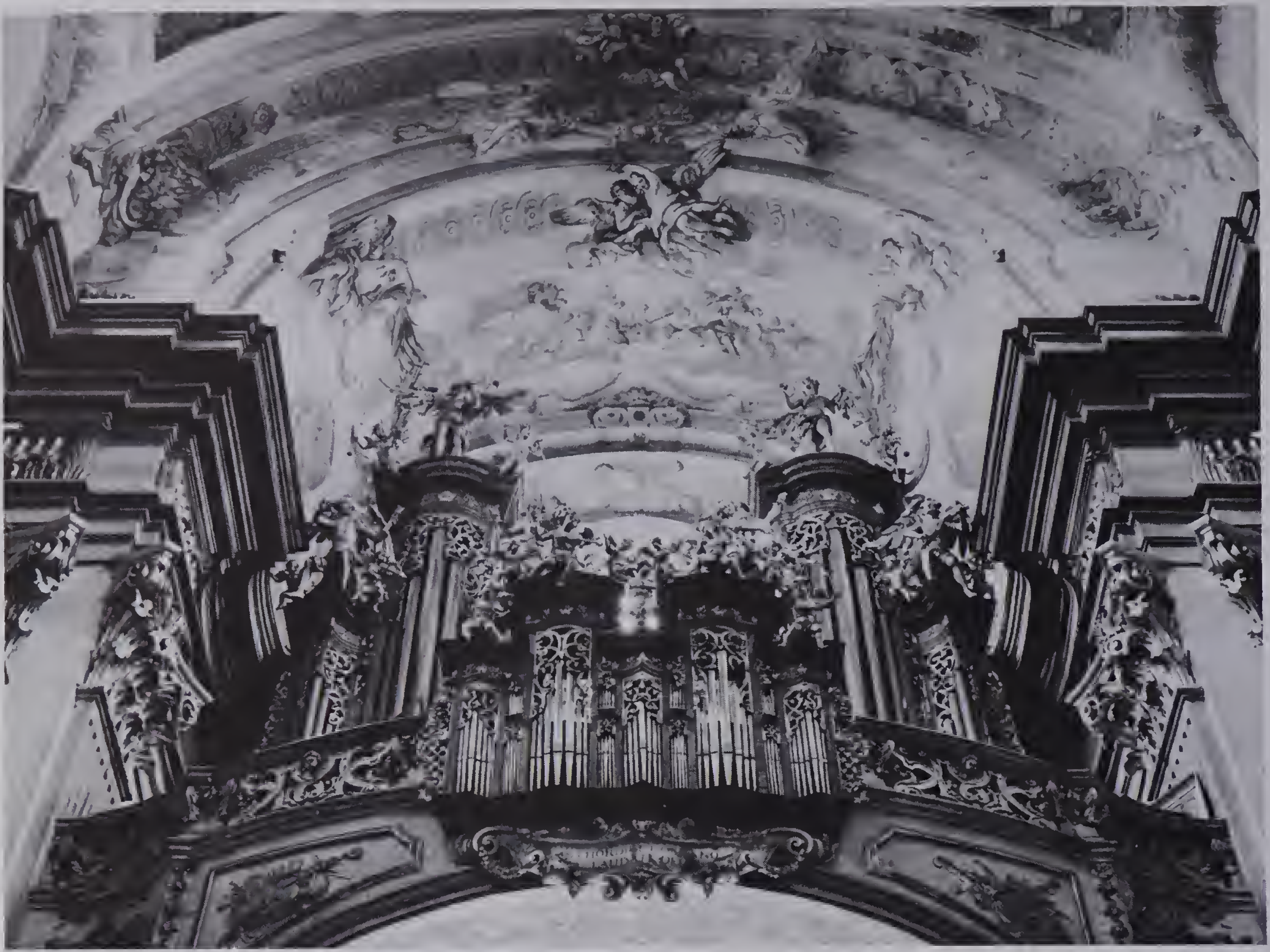

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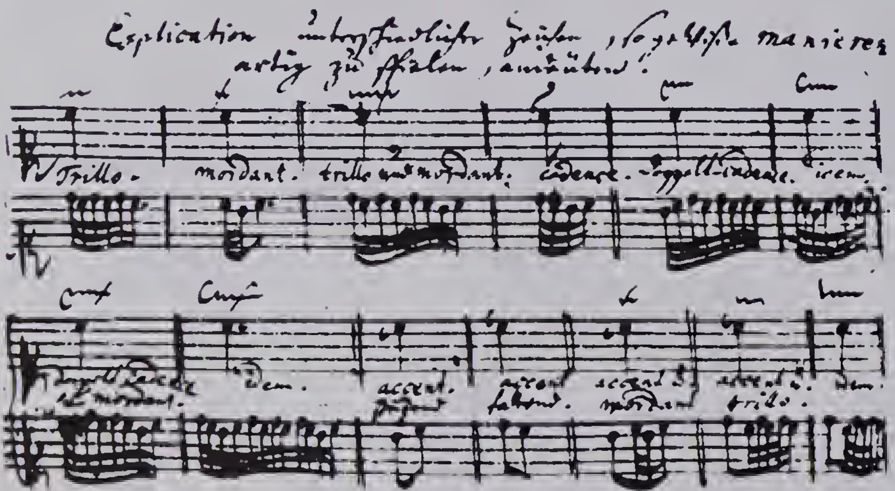

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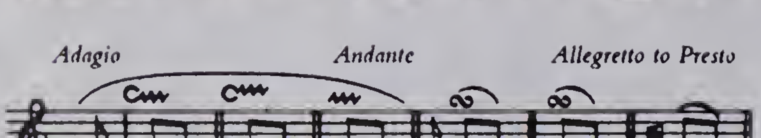

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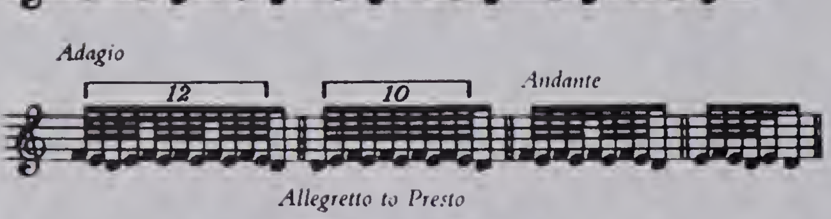

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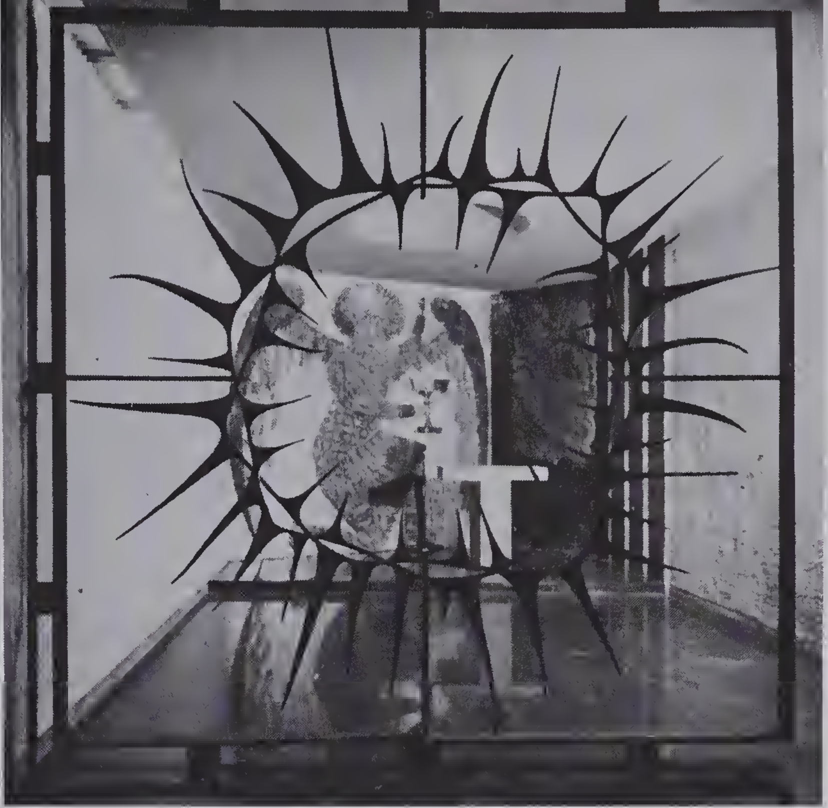
If shapes, patterns and ornaments are to express the spirit of an age it also follows that they must vary from age to age. The eighteenth century Austrian organ, **1**, *is different from the twentieth century English one,* **6**, *although their purpose is the same. The Austrian organ belongs to a period which loved ornaments and thought nothing complete without them. The desire for decoration in the eighteenth century was not confined to architecture and things which could be seen and touched. This picture,* **2**, *shows some of the signs used to indicate musical ornaments. The two examples show how a piece of music might be written,* **3**, *and how it might be performed,* **4**. *Even when such ornaments were not called for by the composer, a performer might decorate his performance by introducing some of his own.*

In Coventry cathedral the bare structure of the building provides most of the pattern. Other patterns, the choir for example, are added to match the character of the structure. The stark, functional pattern of the organ pipes, in a way a natural pattern, fits into the larger pattern of the whole. Even the decorative screen, symbolising the crown of thorns, **5**, *is simplified down to its structure, leaving out all that is not essential. It has become an abstraction and represents the* idea *of the crown of thorns. Representations of figures in Coventry Cathedral are also simplified and there are few of them.*



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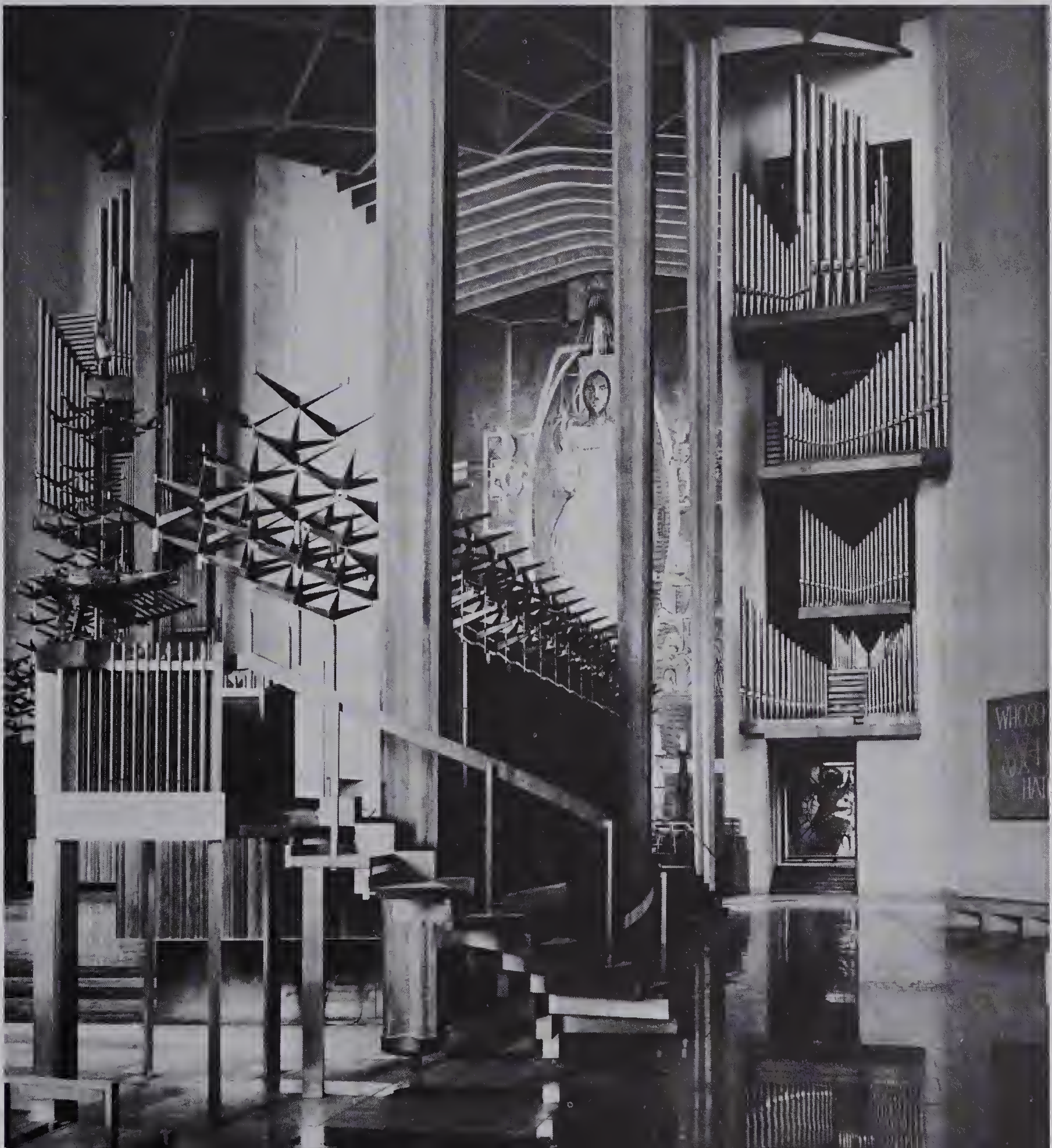

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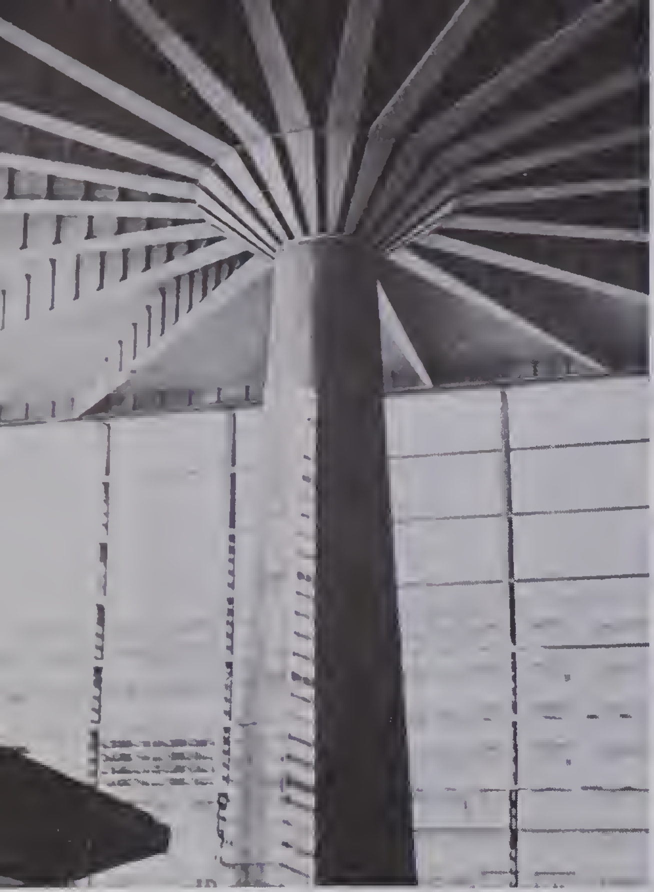

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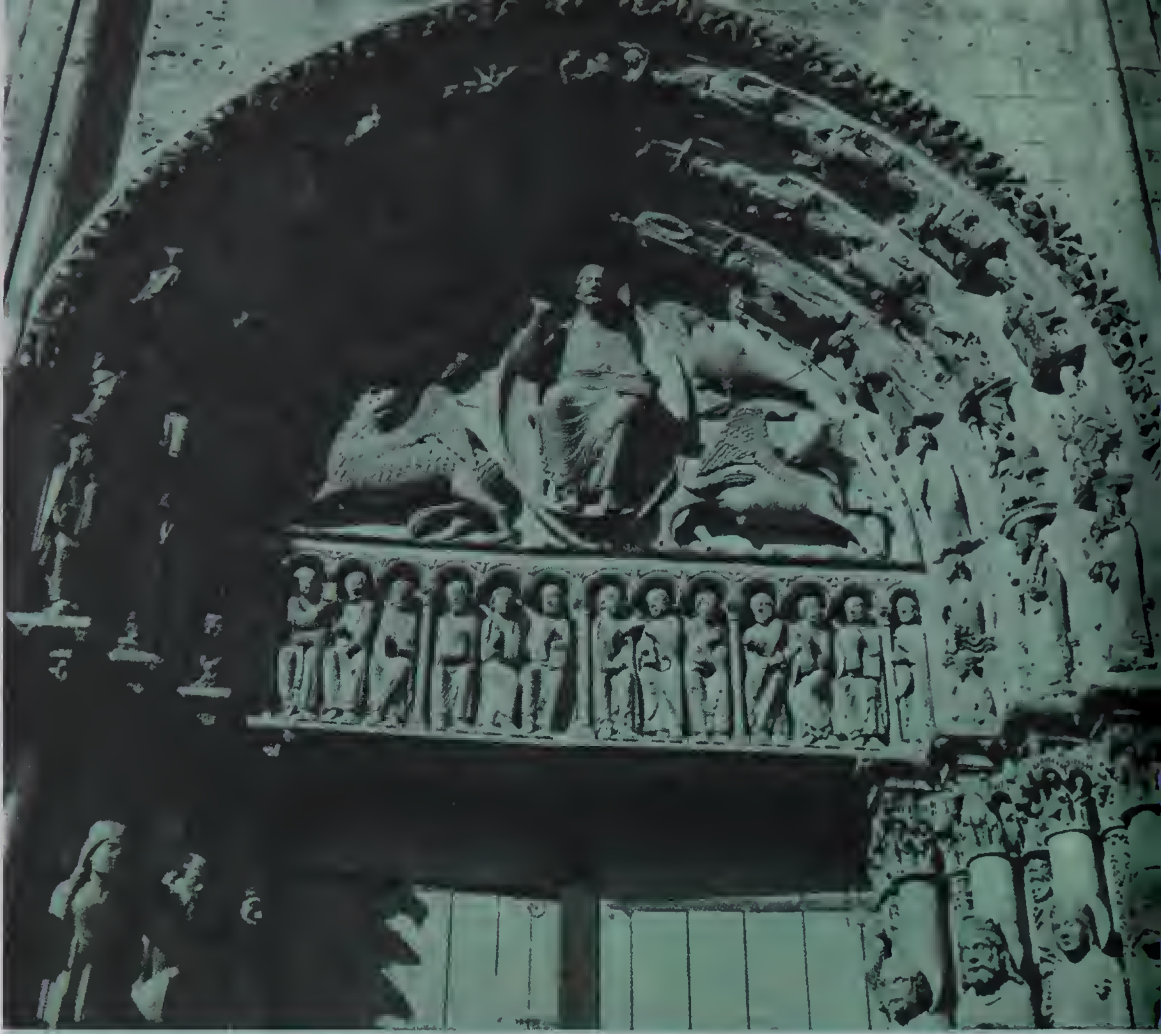

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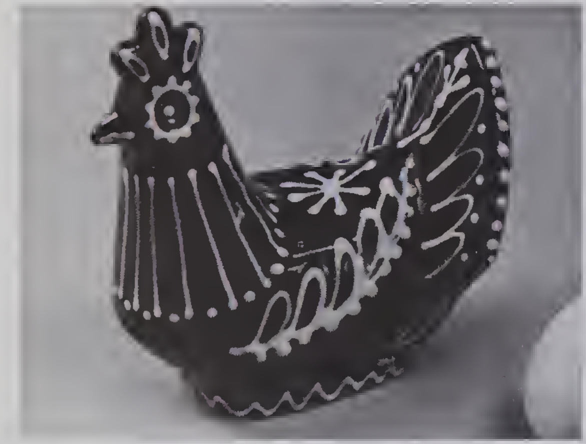

3

TO SUM UP

The surface of a shape should enhance it and not conflict with it. It will do this only if it is related to the shape, for instance by a common process or a common purpose or a common character. Such relationships always exist in natural forms, and if we learn to look for these and recognise them we shall be better able to judge man-made things.

EXERCISES

1. In this hen, **3**, a good pottery shape and a good pottery pattern are in perfect relationship. Find similarly satisfactory relationships in other objects.
2. The column from Nervi's Hall of Labour in Turin, **1**, supports a section of the ceiling. Its pattern is entirely functional. Find other examples of such functional patterns.
3. The Gothic pattern, **2**, accentuates the functional shape. Find other examples of this kind of combination of pattern and form.
4. Collect objects of particular interest for their pattern, texture and colour. They may be either natural or man-made: bark, feathers, leaves, textiles, wallpapers and so on. Form groups of three or four of

them in which the relationships are particularly good and combine well.

5. Try to find examples of regional and traditional colour schemes.

6

A tool and a building: two efficient shapes

We started Chapter One by looking at a group of pebbles. Do you think that you understand more about their shape because of what you have read and learnt? Before you began this book you might have put them all under the heading of "pebbles"; but now you know that they are different kinds of pebbles, with different shapes, which came about in different ways. By trying to understand the origin of these shapes you also learnt something of their difference, and this is very important not only when we speak of pebbles, but with regard to everything in life.

You cannot prefer one taste to another if they both seem alike, if your palate does not detect a difference between them. Many people will see only a superficial difference between the two clocks, **1**, **2**, or between the two pieces of pottery, **3**, **4**, but we already know that the difference between them is fundamental: they express two different ways of thinking. People who are unaware of such differences miss a very great deal, and when they buy clothes and furniture and decorate their houses, their lack of understanding is shown in many different ways.

If they make a happy choice of colours or shapes, it is probably more a matter of luck than good judgment. On the next page are two rooms. The first consists of a set of bad shapes (can you tell why they are bad?) in which there are no relationships between any two objects. This room belongs to someone to whom pebbles are just pebbles. In the second room we see a number of simple and good shapes which add up to a harmonious yet varied pattern.

Only by learning to understand differences and to discover relationships can one find much meaning in the visible world, or begin to appreciate its beauty. That is why it is so important that we should look critically at our surroundings.

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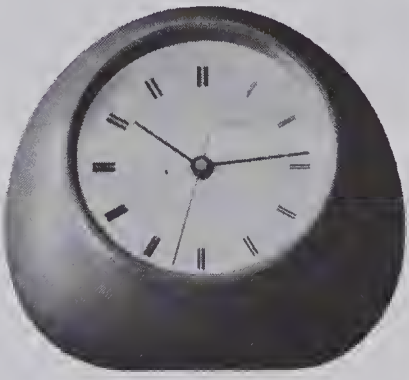

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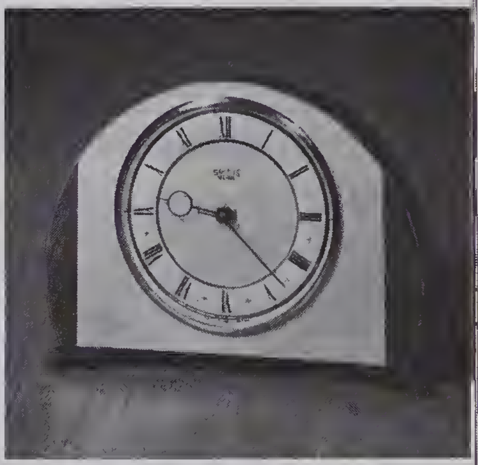

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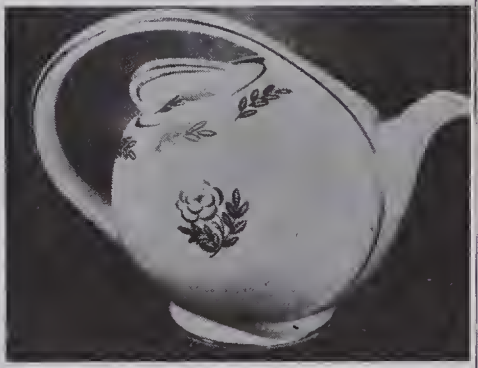

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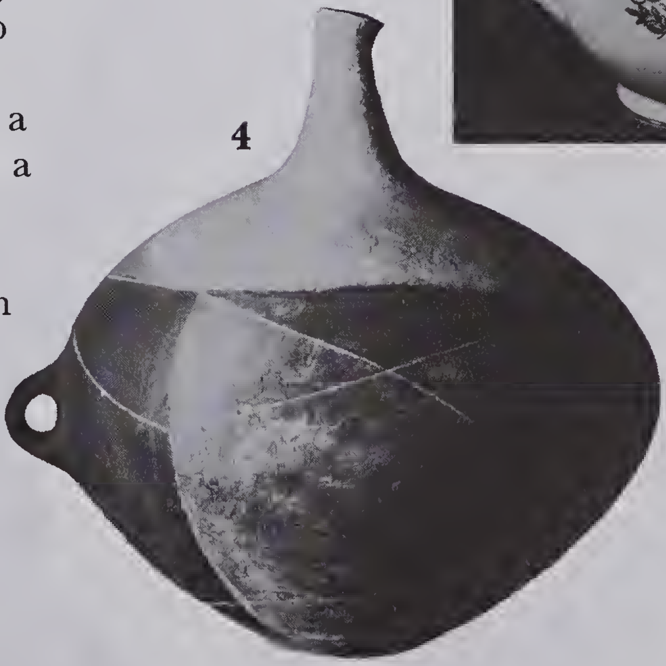

When we admire an animal or a flower we are really admiring an efficient machine. Each part of any living thing, even the scent of a flower or the movement of an animal, has purpose and is not there merely to look beautiful. All living shapes are functional shapes.
A bird's wing is a wonderful piece of engineering. The bone structure, the mechanism which moves the quills, the system of muscles which sets it in motion, all these and many other features are necessary to the efficient working of the wing. The overall shape of a wing is the sum of all these features and it seems graceful to us because its efficiency makes it so. Generally speaking we get more satisfaction from looking at efficient shapes than at inefficient ones.
The natural world can teach us a great deal about how to make efficient and satisfying shapes. For instance we must allow the function of a building and the method of building it to determine its shape. If our pots and pans, tools and machines, houses and factories, roads and cities were constructed as truly functional shapes we should create surroundings as closely in keeping with the natural world as it is possible for man-made surroundings to be. The pattern formed by such surroundings would be both varied and harmonious. This pattern would be an ideal setting to our lives; it is in fact the kind of pattern which in Part One we learnt is an essential condition of human life at its best.
It is not easy for us to create such efficient and logical shapes; much thought, imagination and effort are needed. On the following pages, however, you can see two existing examples which show that it is possible. Each is perfect in its own way and when you have read and seen how they were arrived at you will understand why perfection is so hard to attain.

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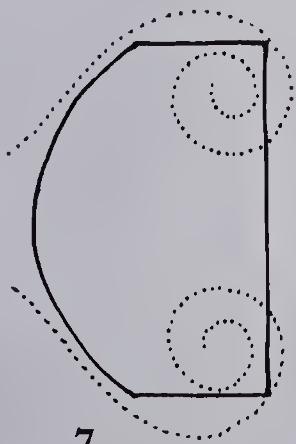
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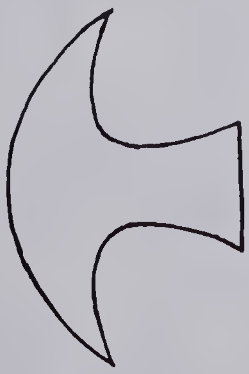
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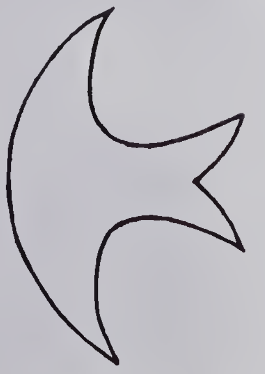
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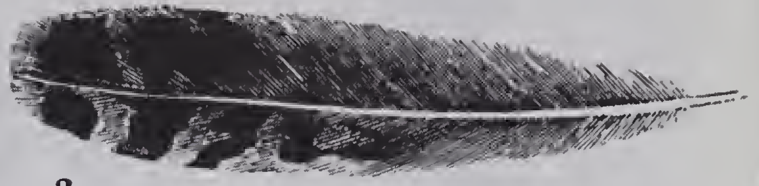
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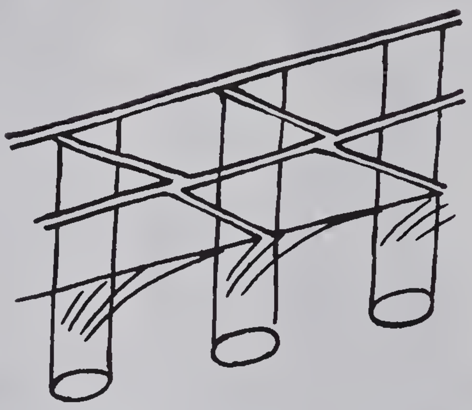
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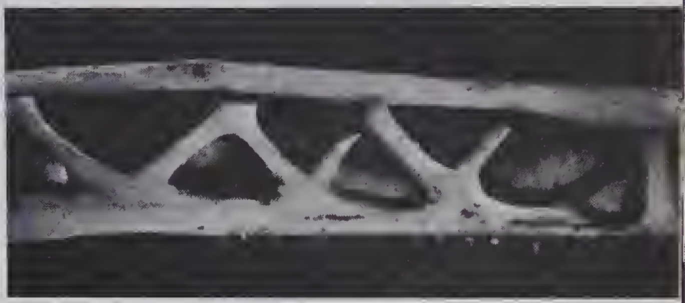
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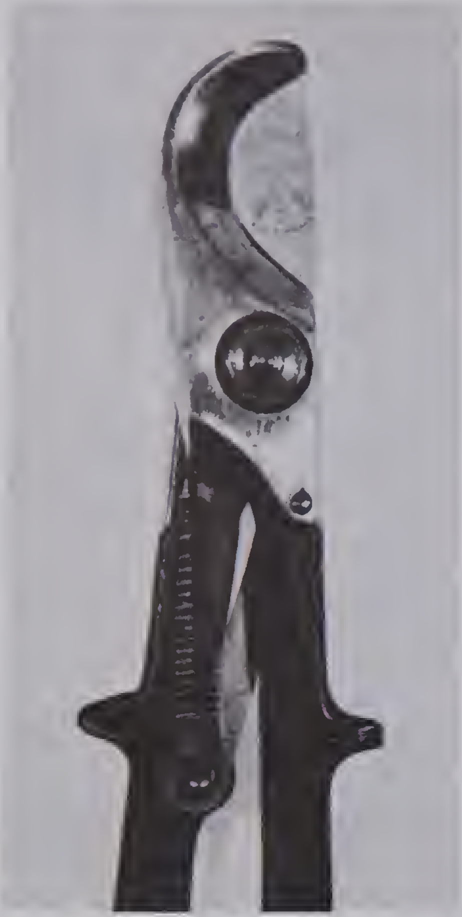
3. The feather, itself a functional shape, is controlled by the mechanism of the bird's wing, **4**. *This arrangement of tendons makes it possible for the feathers to spread out automatically as the wing opens. The tendons also turn each feather at the same time. The wing bones are constructed for extreme lightness, the weight of the bones in a wing being less than the weight of the feathers. The section of a wing bone,* **5**, *shows a definite similarity to the work of engineers.*
If we watch a piece of paper gliding downwards we can see that sharp corners interfere with the flight and that the front edge should be as long as possible. Shape **7** *is better than shape* **6**, *but now the rear corners are in the way of air currents. These portions of the piece of paper are not doing any work and can be cut off,* **8**; *this will increase the efficiency of our shape. The centre part of the tail can be removed for the same reasons,* **9**. *A bird, from its smallest detail to its overall shape is functional.*



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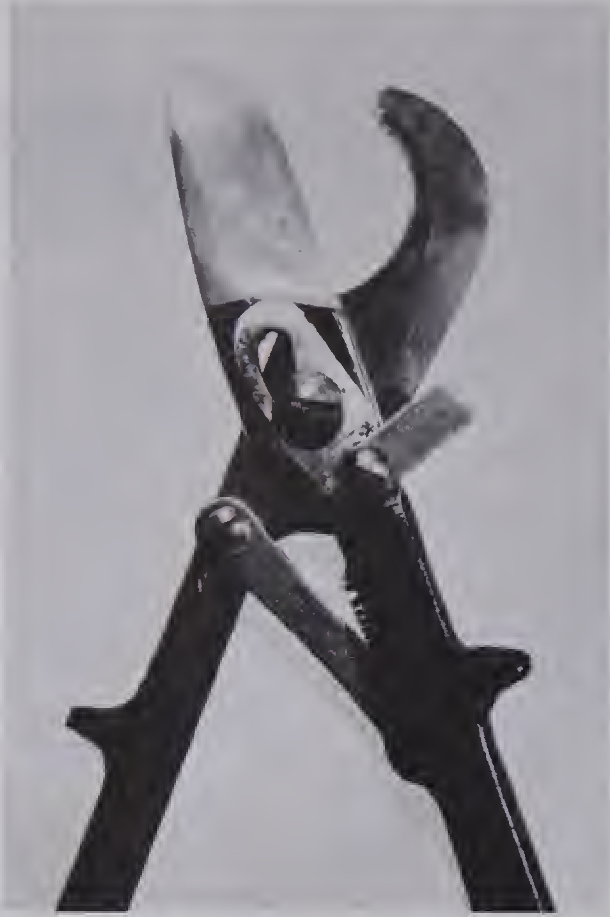

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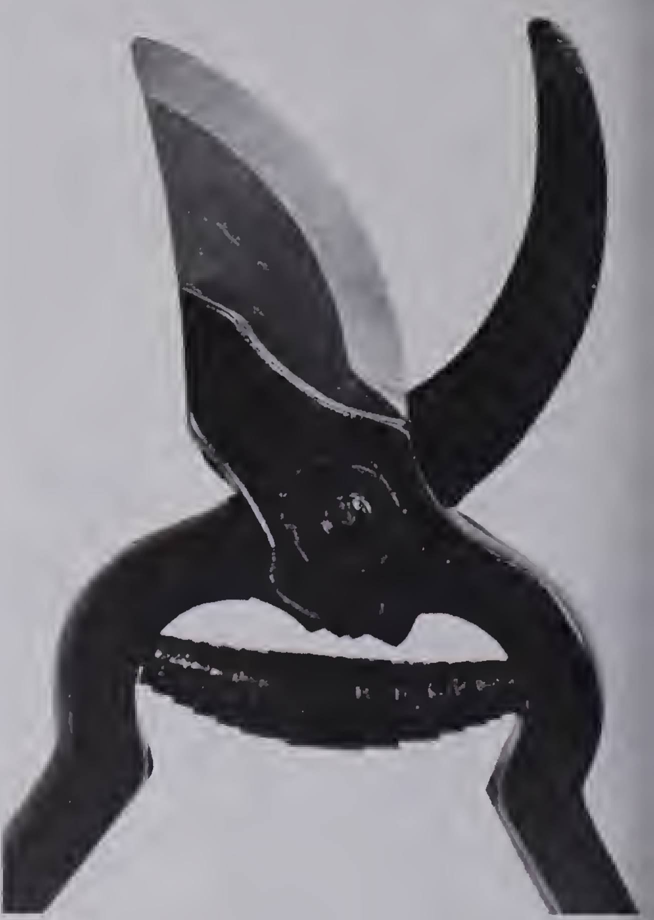

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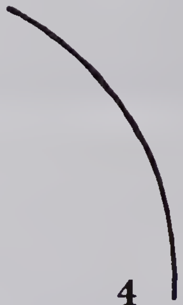
The best and cleanest way of cutting a twig is by the sliding action of a knife, but a pruner allows us to get a lot more force behind the cutting blade. When this pruner, **1–2**, *was first made, the designer tried to give it a knife-cut movement and the pictures show how he achieved it. It was later found that a similar effect could be achieved by much simpler means: a curved blade,* **3**. *This simplified the whole mechanism. Some years later it was decided to re-design the pruner and a start was made with the shape of the blade. By changing the curvature of the cutting blade,* **4**, *it was found that less force was required for cutting. The curved edge of the other blade was then designed so that an average twig of about ⅜ in. diameter could be cut near the pivot where it is easiest to cut, without having to open the blades too wide,* **5**. *You can see that the new curvatures will do the job much better than the old. The outer edges of both blades were designed to give the blades enough strength,* **6**. *Because this new cutting blade depended for its effect on a smoothly curved edge of great precision it could no longer be ground by hand as it used to be, but had to be made in a special profiling machine,* **7**, *which incidentally greatly reduced the time taken for manufacture. At the same time it was found that a second pivot,* **8**,



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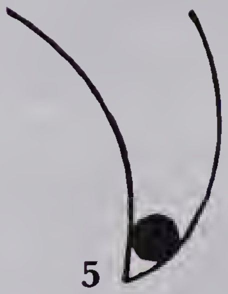

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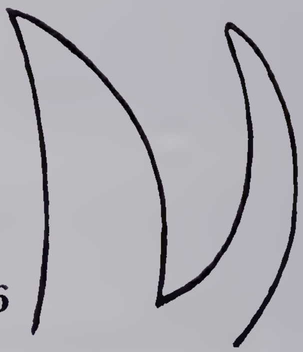

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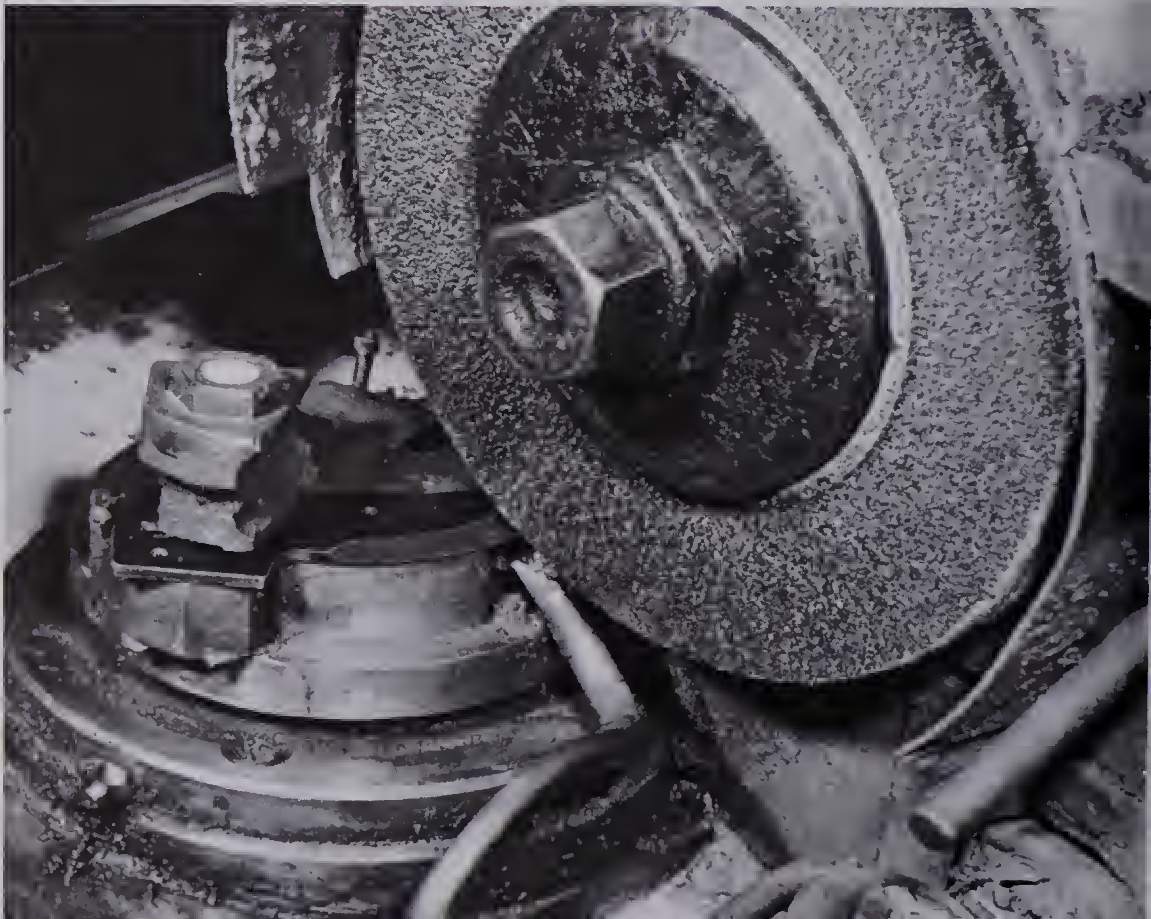

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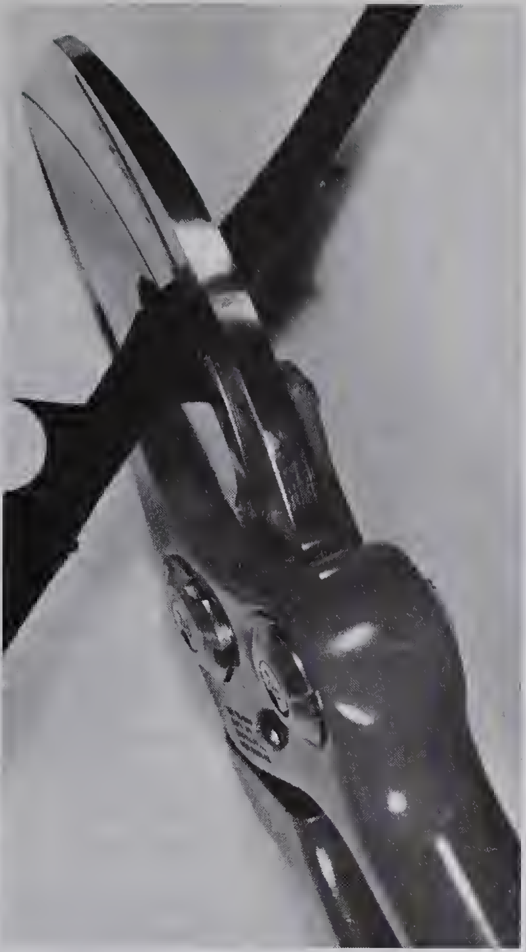

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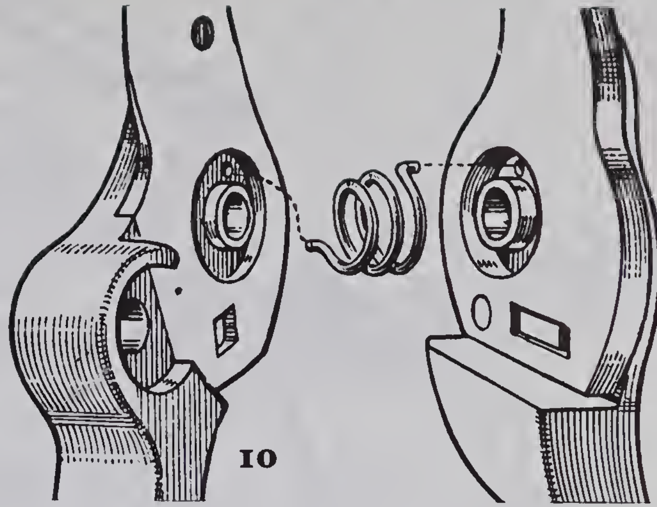
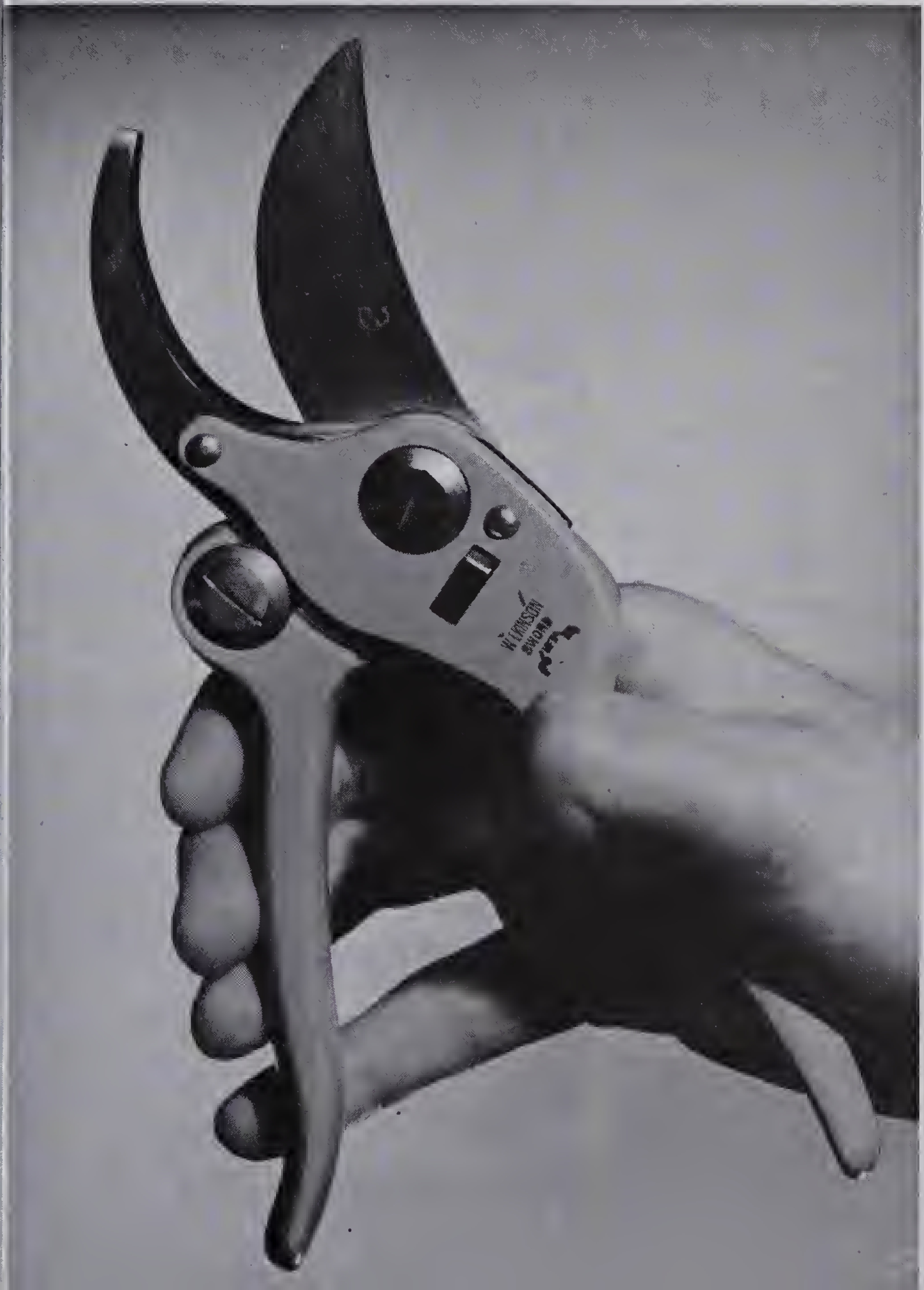


10

would help to prevent the blades being twisted apart by thicker twigs, **9**. *This second pivot is really a groove in which the outer edge of the second blade runs rather like a rail. An ordinary groove would not have been so good because adjustments might become necessary as the blade got worn. The pivot also provides a lubrication point.*

These requirements meant that the blades had to be made separately. Since the handles could then be considered in their own right it was possible to cast them of a light alloy, in the shape most useful to a gardener. They were also designed so that the hand would be as far away from the main pivot as possible, for greater leverage, **11**.

In a tool of this nature the weight should be at the front for this makes it easy to use. By making the handles of a light metal and the blades of steel, the balance of the whole tool has been moved forward, which helps its operation. Furthermore, the lightweight handles make the heavy returning spring of the earlier models quite unnecessary; a small spiral spring between the blades does the job just as well, **10**. *Instead of the heavy safety catch on the earlier model a small ratchet is used. This gives the whole tool a smooth, uncluttered appearance, and improves its efficiency. This pruner is one of the best-designed tools of recent years. You can see that in its development one idea followed another and the final shape is the result of a network of interlocking ideas. The ideas mentioned here are not the only ones which resulted in the final shape of this tool, but they help to show that even a simple looking shape like the pruner requires a lot of imaginative thinking. We might even compare it from this point of view with a Gothic cathedral or Le Corbusier's chapel.*



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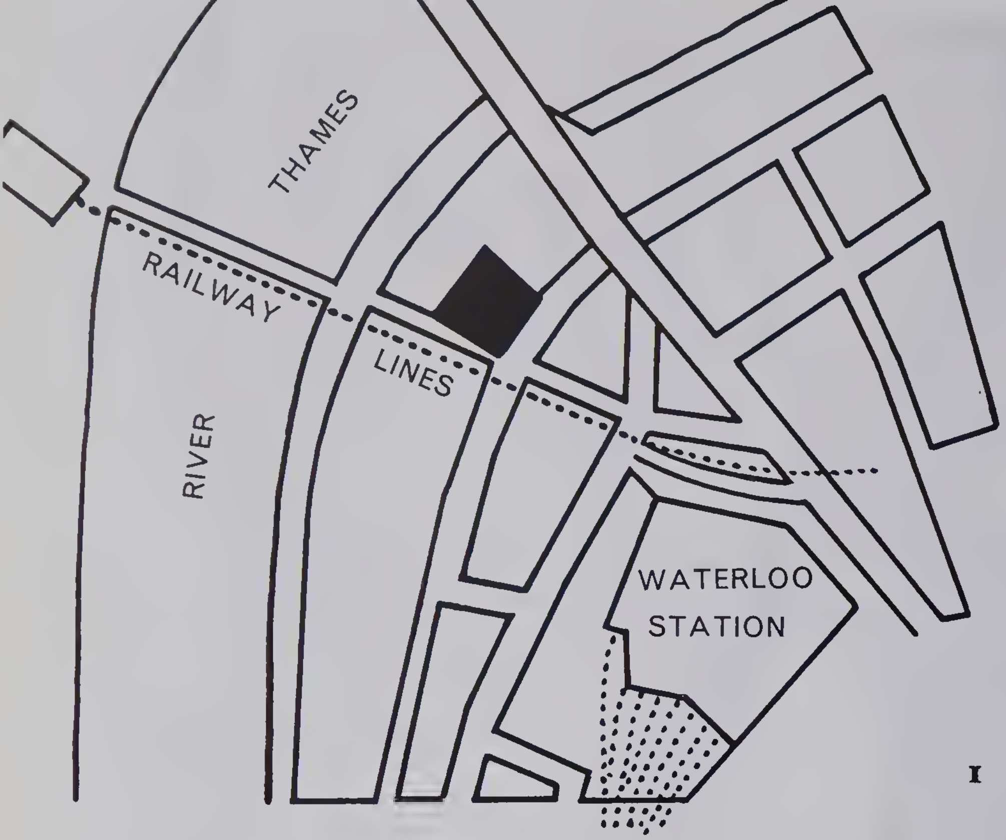
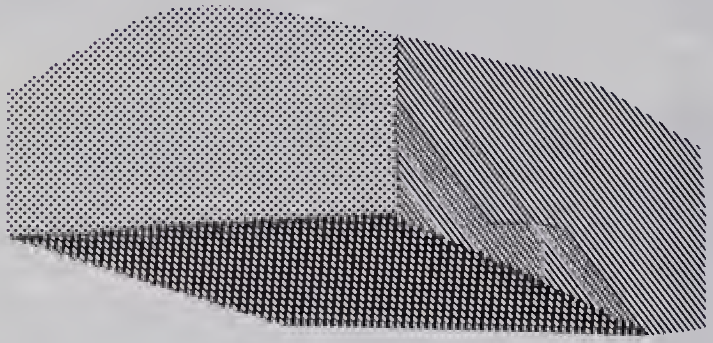


1

When the Royal Festival Hall was planned the only available site was a smallish, cramped plot on the South Bank of the Thames in London, and this piece of land was surrounded by traffic noises of every description, **1**. *These two factors largely determined the shape which this concert hall was to take. The shape of the auditorium itself was the outcome of a number of technical considerations, the quality of sound chief amongst them. You can see from the pictures that it varies considerably from other modern concert halls,* **4**. *Both orchestra platform and seating are raked (sloping), separated by a reflecting surface of slate on the floor. The architects then placed this shape,* **2**, *on pillars inside a box-like outer case,* **3**. *The air space between the auditorium and the outer walls serves to insulate it from the noise of London's traffic. This arrangement saves a great deal of floor area, for entrance hall, booking offices and buffets can be accommodated underneath the auditorium, while corridors and staircases, bars and restaurants, washrooms, changing rooms, offices, are contained in the rest of the insulation space. The roof of the auditorium which projects upwards beyond the outer case has a double shell of reinforced concrete to complete the insulation.*



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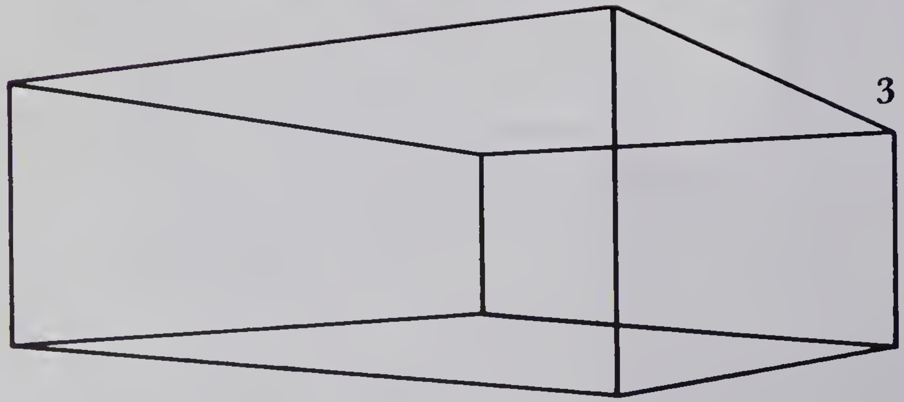

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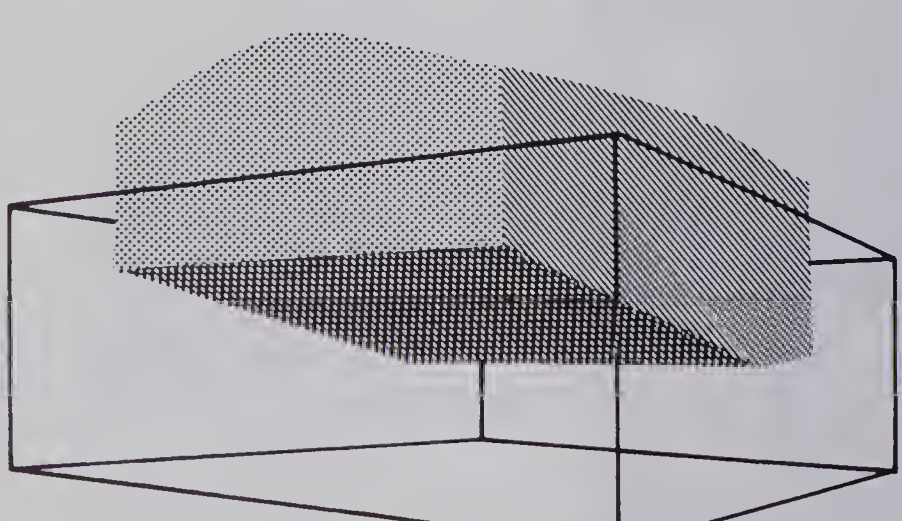

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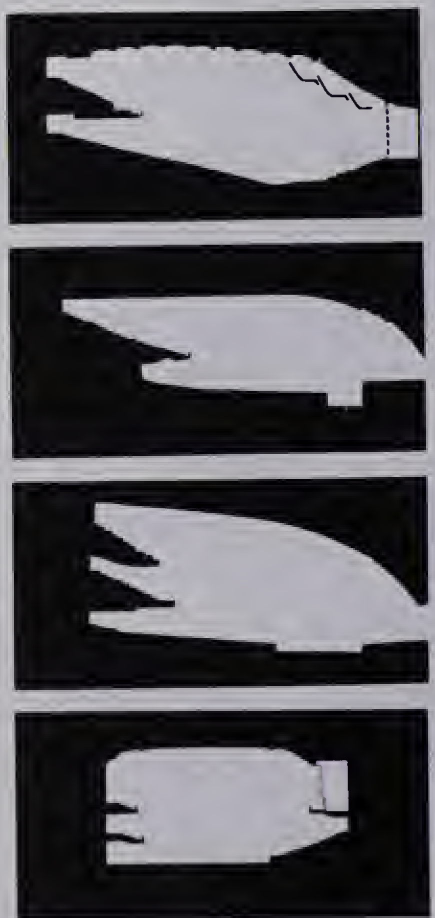
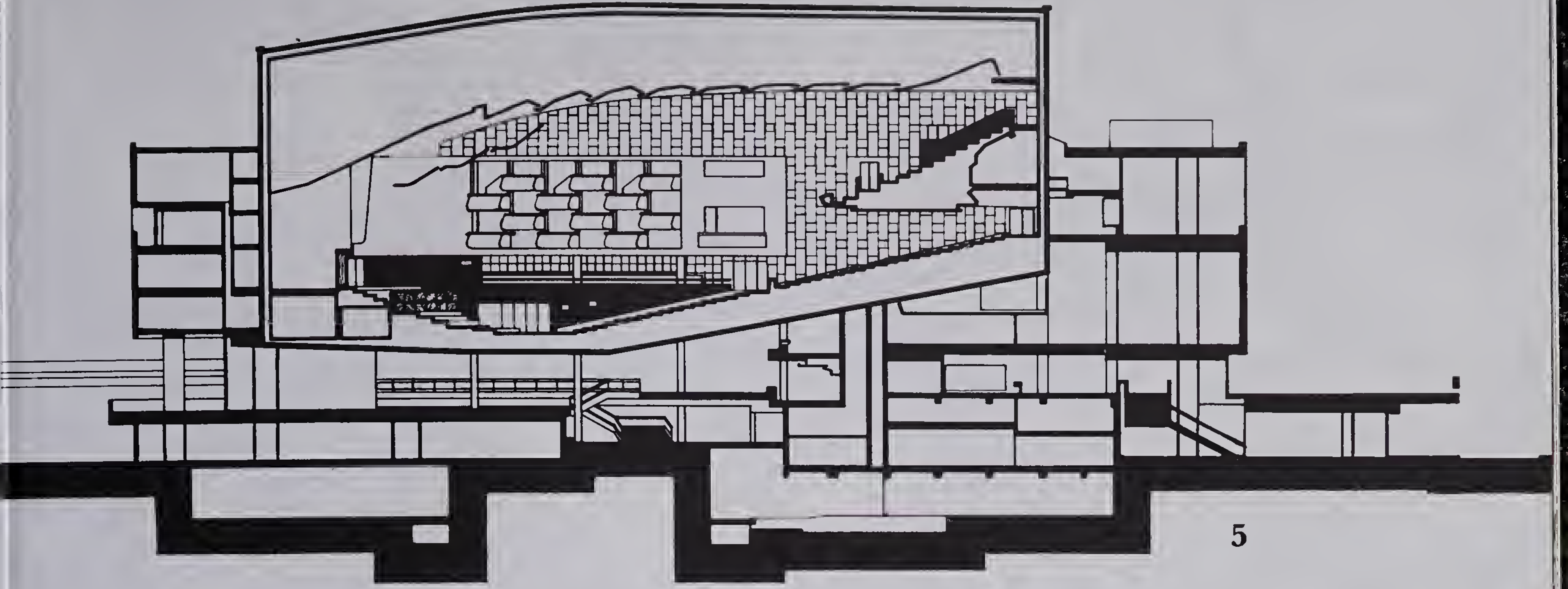


Royal Festival Hall

Concert Hall, Buffalo, U.S.

Concert Hall, Paris

Queen's Hall, London (now destroyed)



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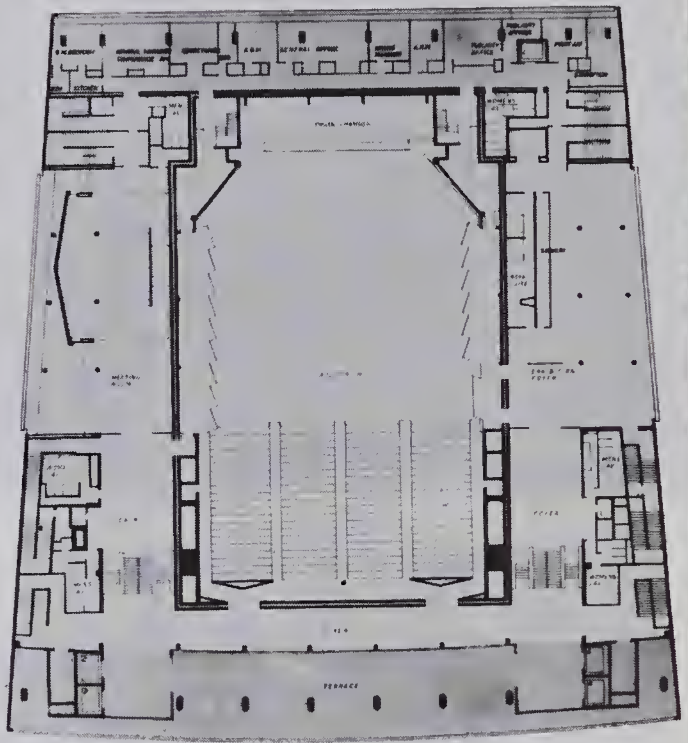

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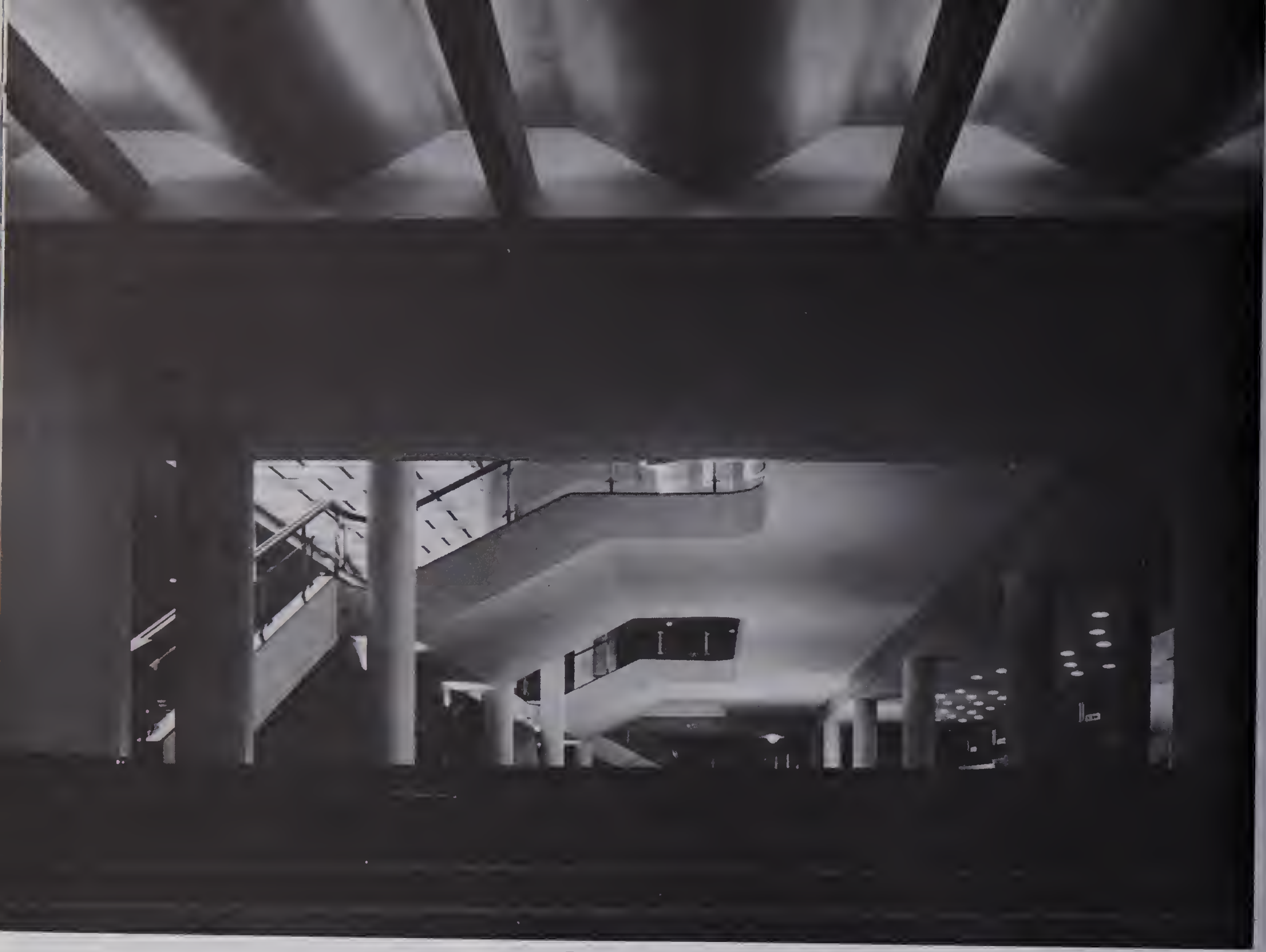
The Section, **5**, *and plan,* **7**, *of the Royal Festival Hall show the relationship of the auditorium and the surrounding space. We cannot appreciate the shape of the Royal Festival Hall,* **6**, **8**, *unless we understand the reasons which caused it. Had it not been built in such a noisy place and on such a restricted site, it would probably have taken a different shape.*



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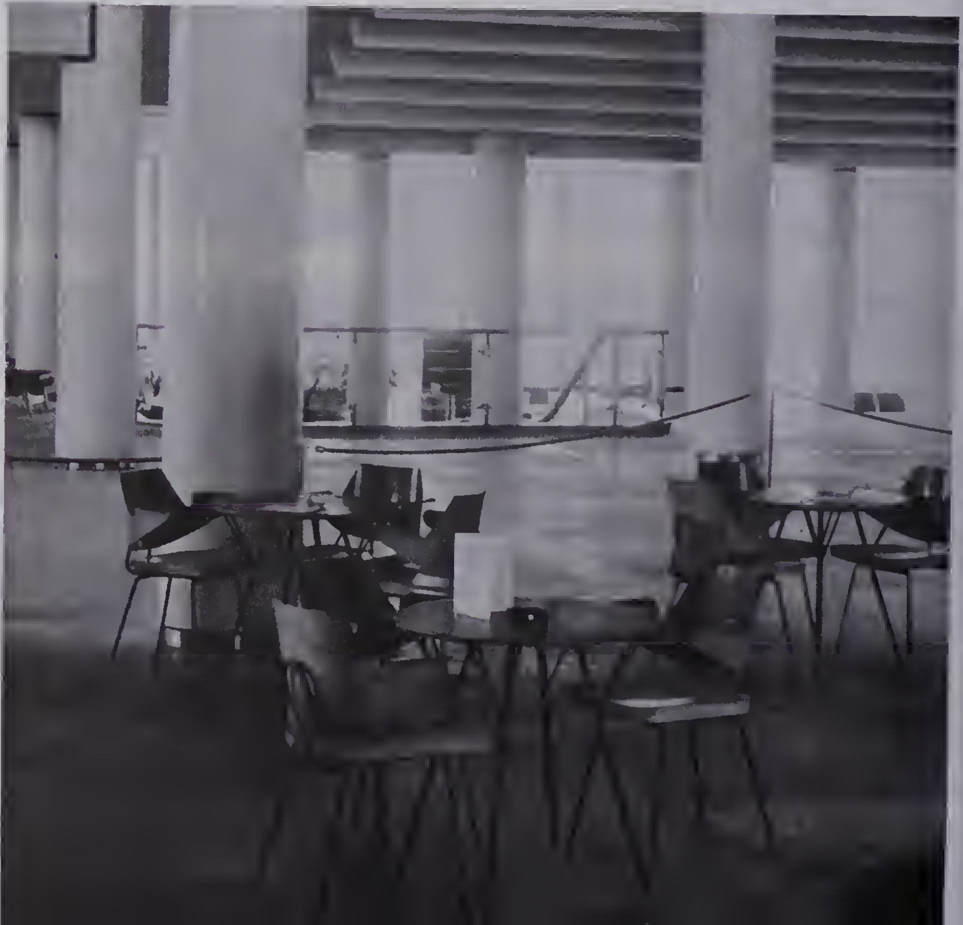
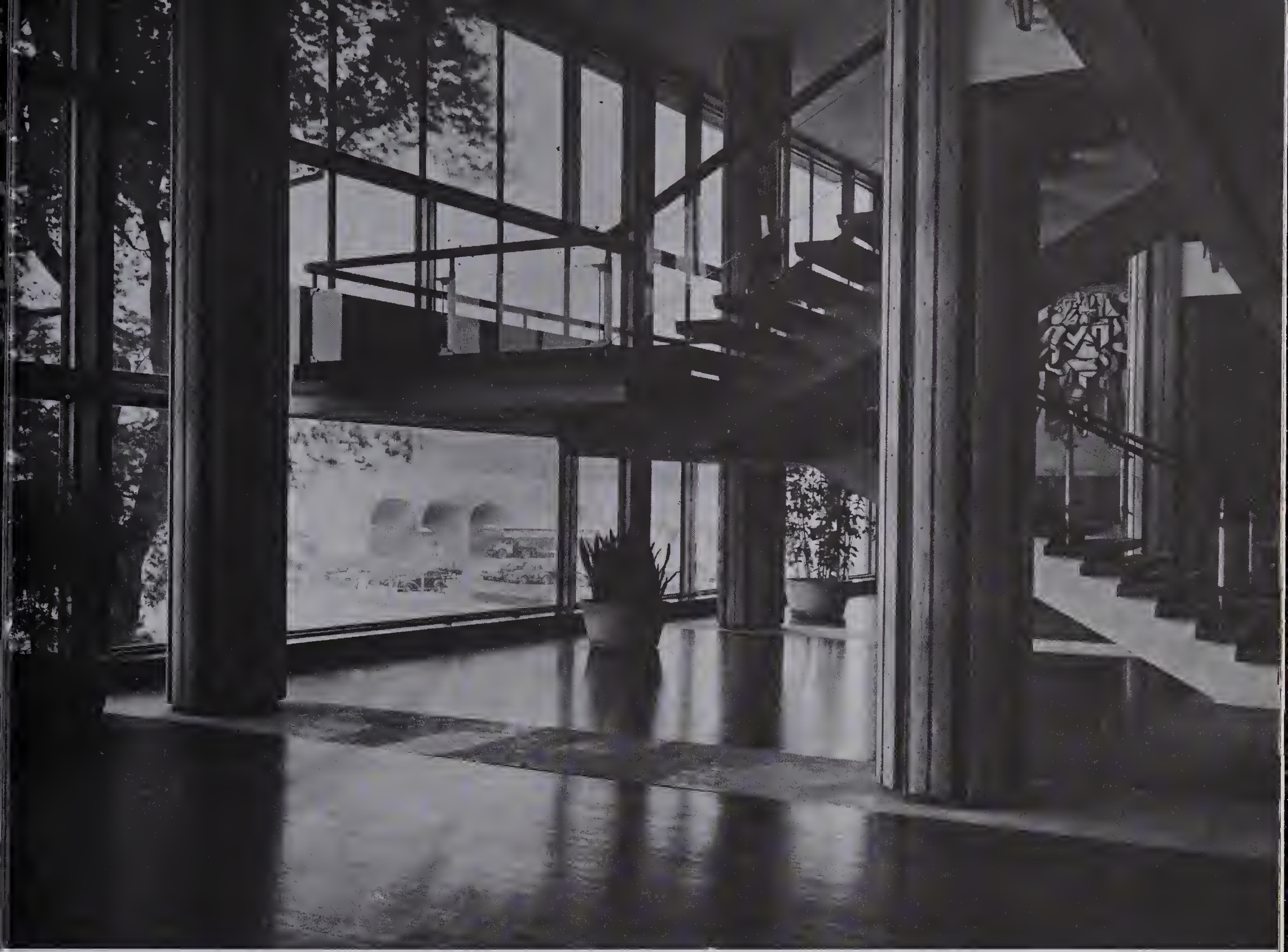


By using imagination and ingenuity the architects have provided staircases, restaurants, and promenading areas of great spaciousness. Nowhere is the structure of this building hidden. The pillars in pictures **1**, **2**, **3** *are the ones which hold the whole auditorium aloft. The raked underside of the auditorium can be seen quite clearly from the foyer,* **2**. *By using different kinds of lighting (how many can you see in the pictures?) and as much glass as possible the architects have increased the feeling of airiness and spaciousness in this part of the building. There are no narrow passages – only wide and open spaces.*

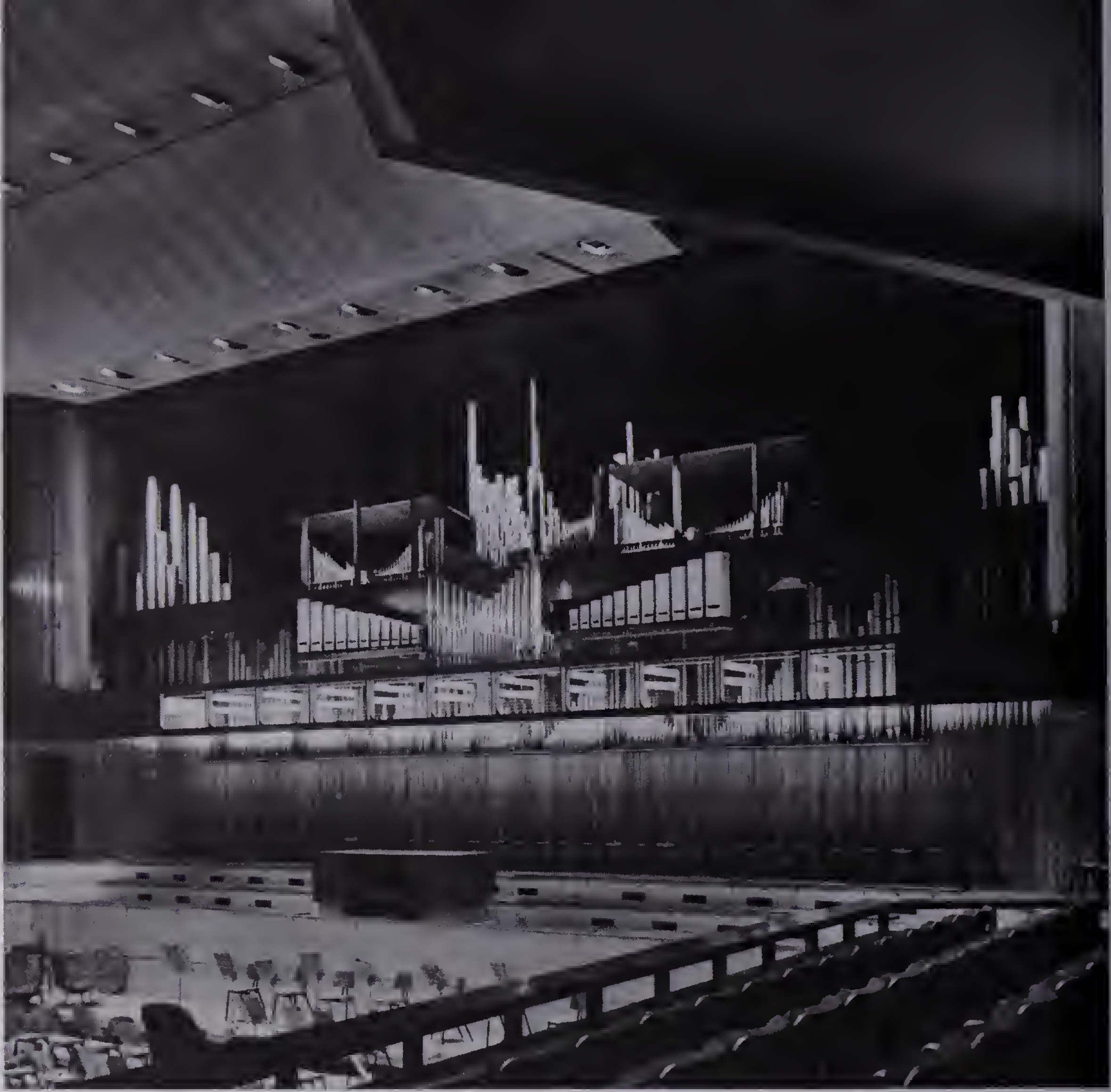


3

4

So perfect is the sound insulation that the many trains which pass within a few yards of the hall cannot be heard inside.

The auditorium itself has the purposefulness and precision of a machine. Everything in it is necessary to its efficient functioning. The ceiling is broken up into a series of independently suspended panels, because the vibration of a one-piece ceiling of this size would distort the sound. The panels are shaped to reflect and absorb sound so as to give the best results. The wall surfaces are not merely decorative, but play their part in the scheme of obtaining the best possible sound. As the diagram, **5**, *shows, some of them absorb sound, others reflect it, or only part of it, and these areas have been worked out so that the best possible balance of sound is achieved. The boxes,* **3**, *which seem to float in mid-air, are placed in such a way that people who sit in them can see as well as hear. All the many requirements of a concert hall are here met in such a way that a logical and satisfying shape results. The impressive pattern of the great organ,* **1**, *seems a fitting centre piece.*



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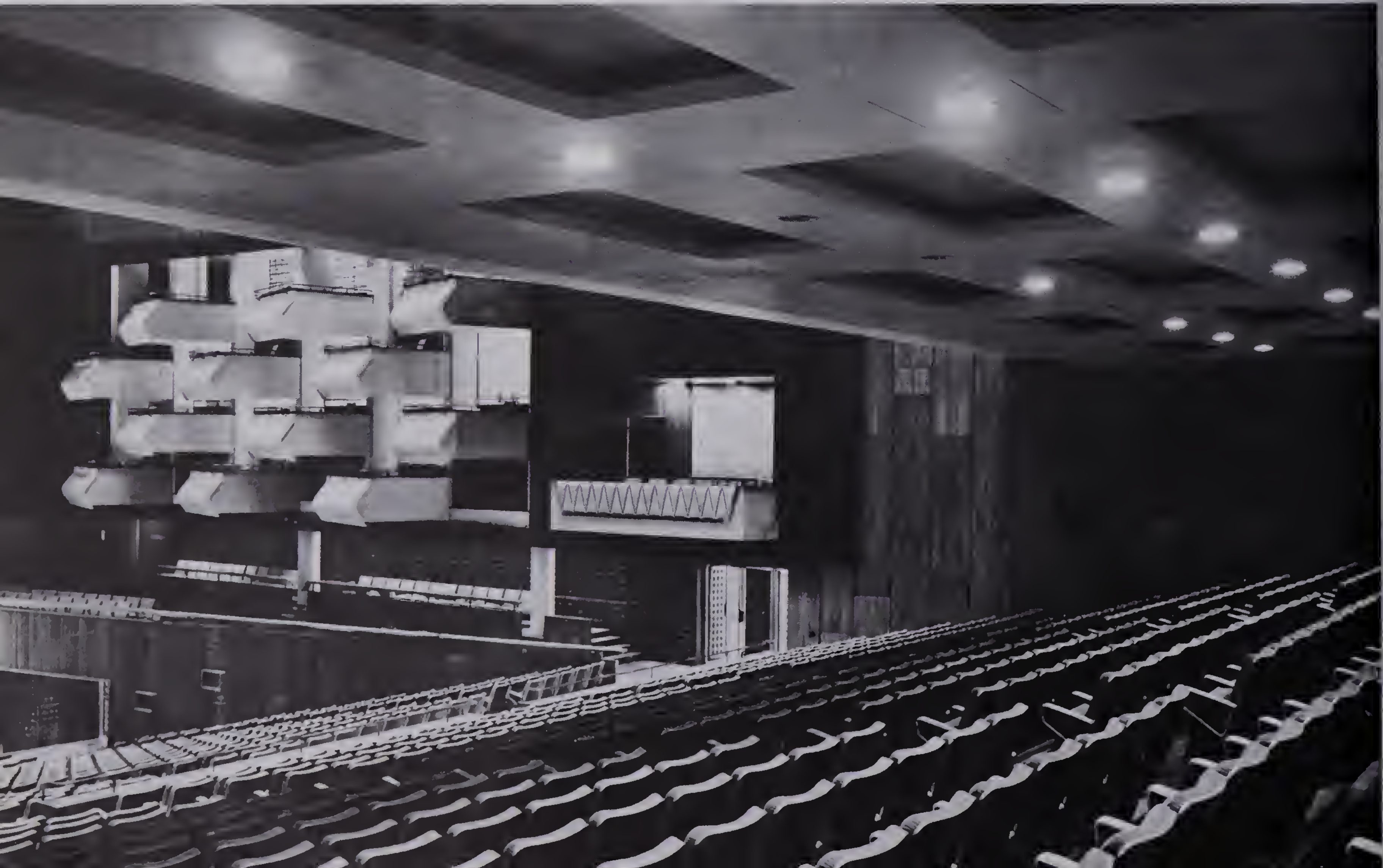

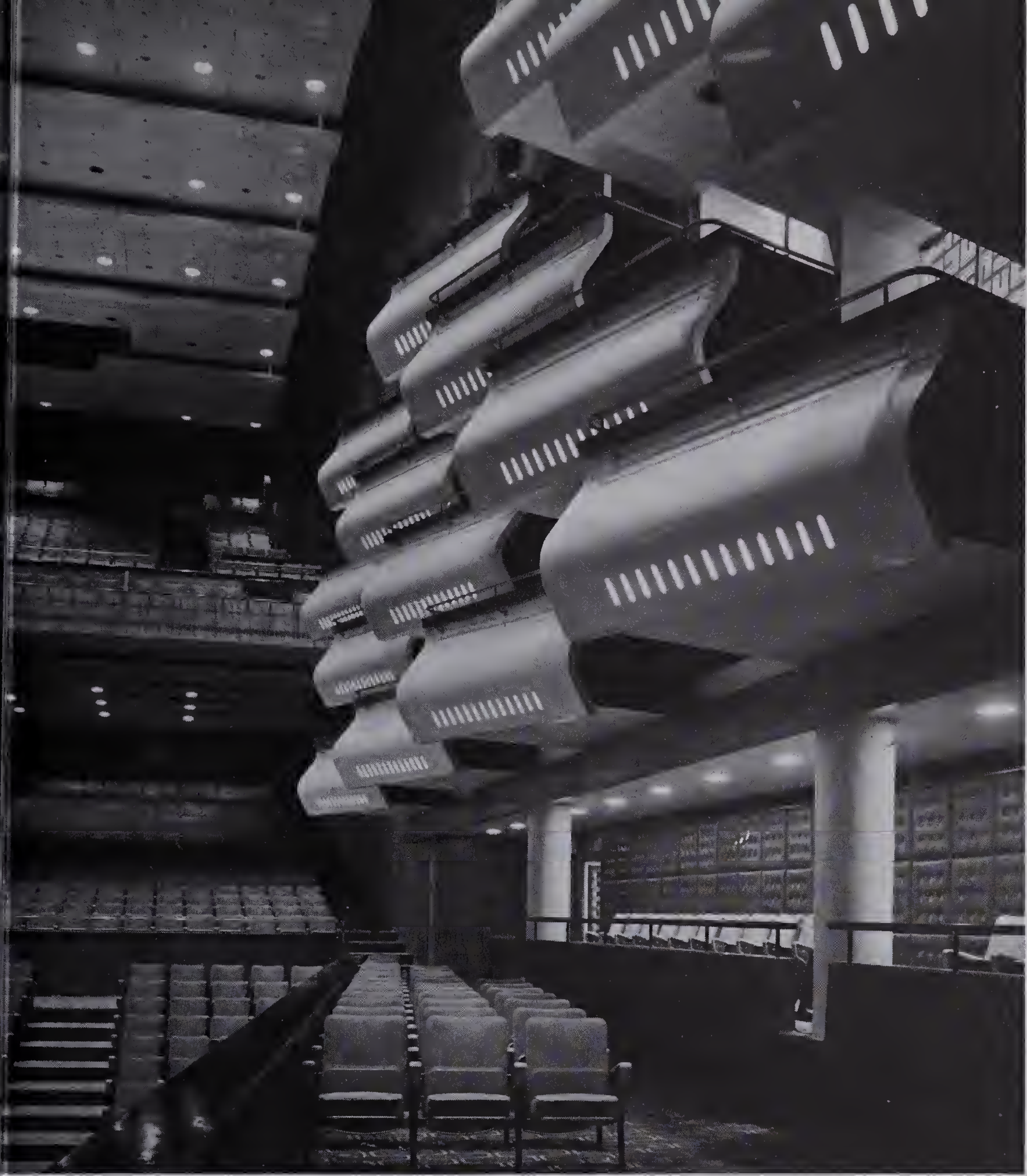

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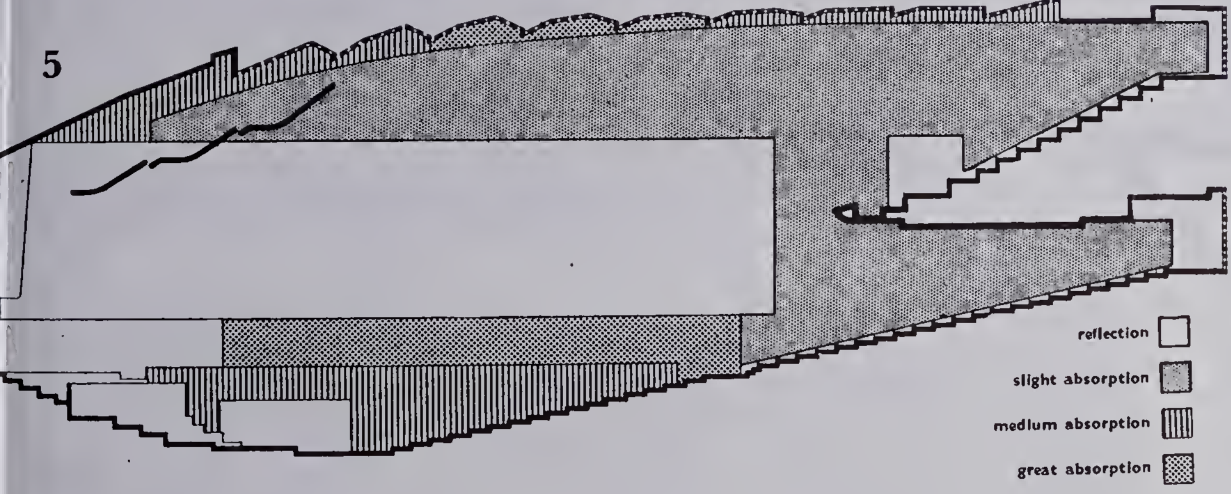
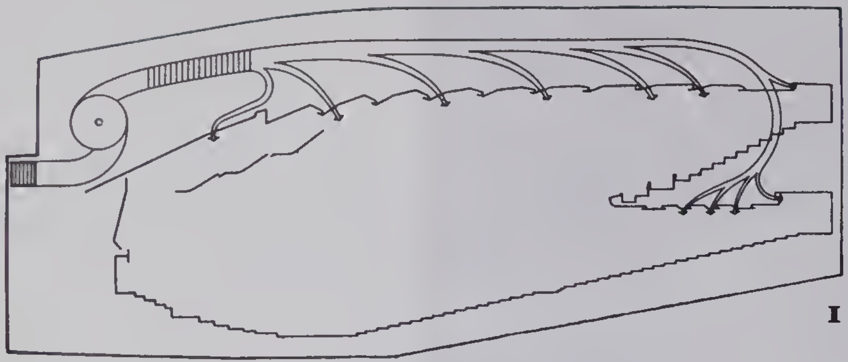


The seats, **4**, *are not only very comfortable without being too bulky, but they also contain a perforated panel on the underside with sound-absorbing material behind it. The quality of sound depends on whether we hear it in an empty room or a room full of people. During rehearsal a concert hall is generally empty; at some concerts every seat may be taken, at others many may be empty. All this could change the sound considerably. With the pad of sound absorbing material under each seat, these changes are eliminated. When a seat is unused the underside will face the orchestra and will absorb as much sound as a person would. The balance of sound over the whole hall is always the same, whether the seats are full or empty.*

There are numerous other problems which the architects of the Festival Hall had to solve. The temperature and moisture of the air can be kept constant by a vast air conditioning plant which blows fresh air into the hall through openings in the ceiling, **1**, *and extracts stale air through similar openings under the seats of the auditorium,* **2**. *The lighting system must be adaptable for the many purposes of the hall,* **3**. *Some of the light is reflected downwards by the curved surfaces of the ceiling panels, but there is also direct light, including smaller lights which are kept on during the performance so that programme notes or scores may be read. The problems involved*



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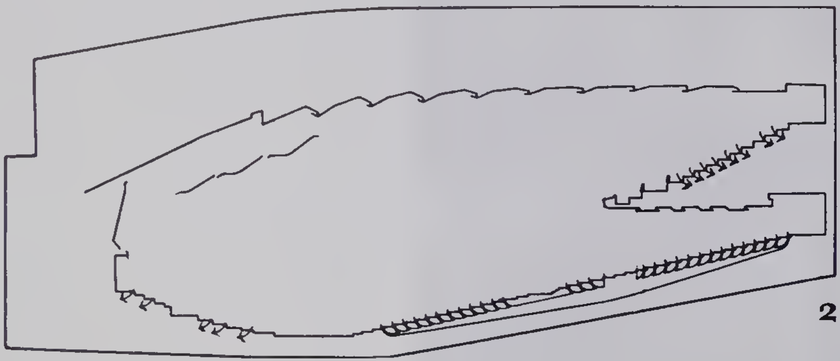

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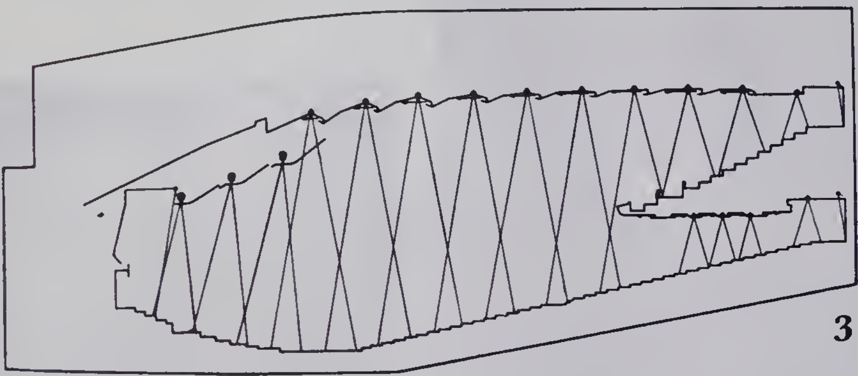

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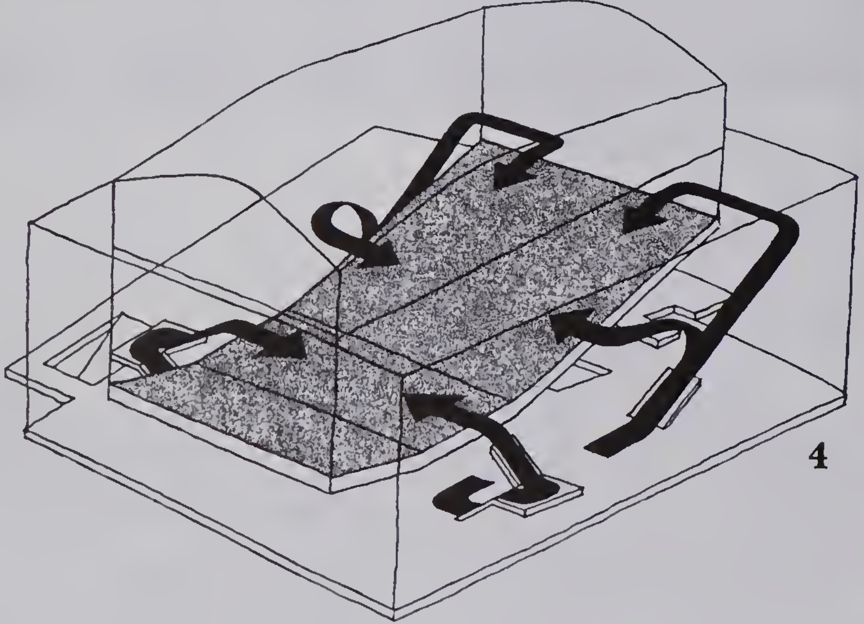

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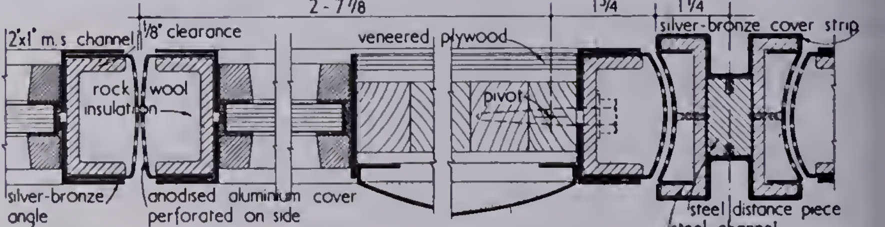
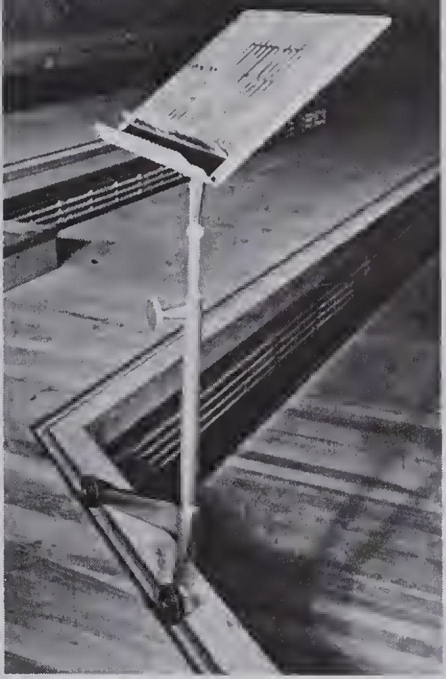


6

in planning such a building range from accommodating the flow of concert goers, **4** *(so that the auditorium may fill and empty with the least delay and people may walk about freely), to such details as the sound-insulation of doors,* **6**, *the design of music stands,* **7**, *and of lamps,* **8**.
One often forgets that even such small details, which we too often take for granted, should be planned as part of the whole design, if they are to be really effective. For instance, the music stands, **7**, *fit into grooves and slide along on the edge of each step of the orchestra platform. They take up less space than the usual tripods and are less liable to topple over.*



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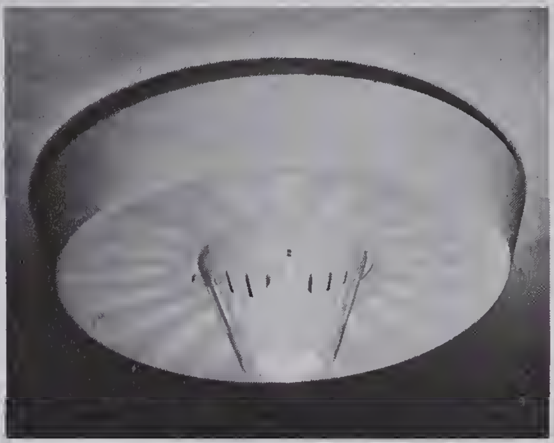
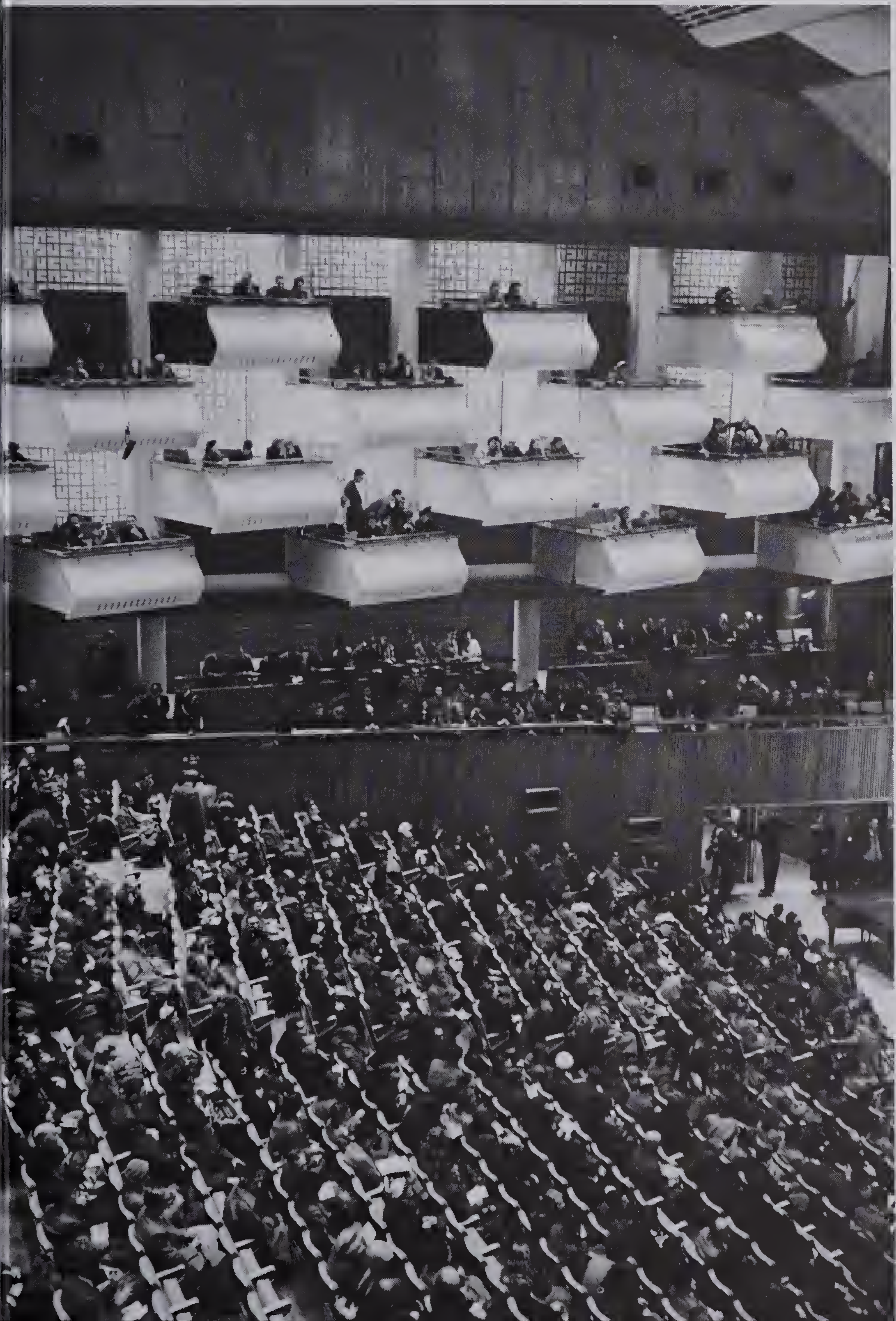
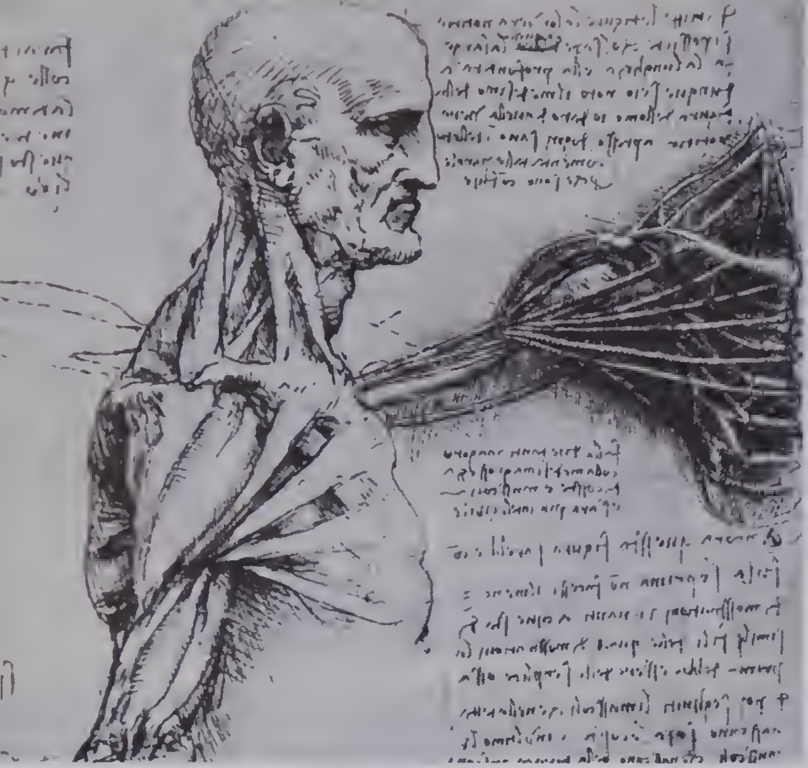




9

10

All these details and many more give the Royal Festival Hall its special character and make it such an efficient – and satisfying – machine. Perhaps one day you will experience its beauty for yourself. Pictures may explain many things but they cannot convey everything. They can show the colour, shape and pattern of a strawberry, but how can they describe its flavour?



1

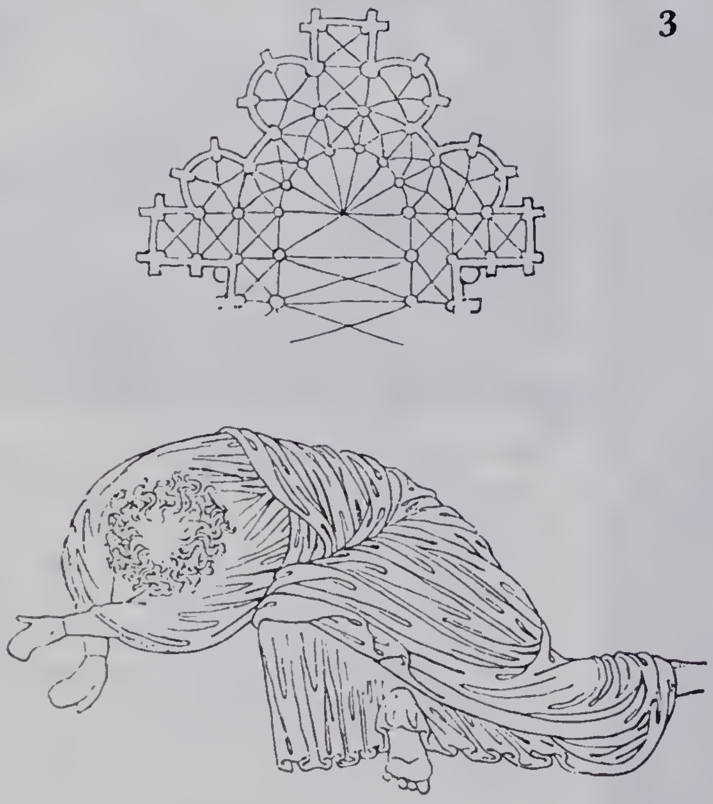
The natural world, as we have seen, is composed of a series of relationships. The efficiency and beauty of our man-made world will depend on our ability to understand and interpret these relationships. This understanding of nature can be gained in two ways, through what we can broadly call science and art. Both the scientists and the artists examine nature, find the laws and relationships of nature, and then set them down, each in his own way. The works they produce interpret their observations.

The connection between science and art is much deeper and more real than most people realise. They are two different activities, but they deal with the same thing: the world around us. There was a time when art and science were much closer than they are now. Artist and scientist were often combined in the same person, who would have found it difficult to draw a dividing line between art and science. But even today, when everything is so highly specialised, it is not always easy to distinguish the one from the other. Is architecture an art or a science?

Are the objects you saw on the last few pages works of art or of science? Perhaps they are a bit of both. A building or a tool must be judged by its efficiency and its appearance. In this museum, **4**, industrial objects made in this century are on show. Can you say which of these objects are works of art and which are works of science?

2

3

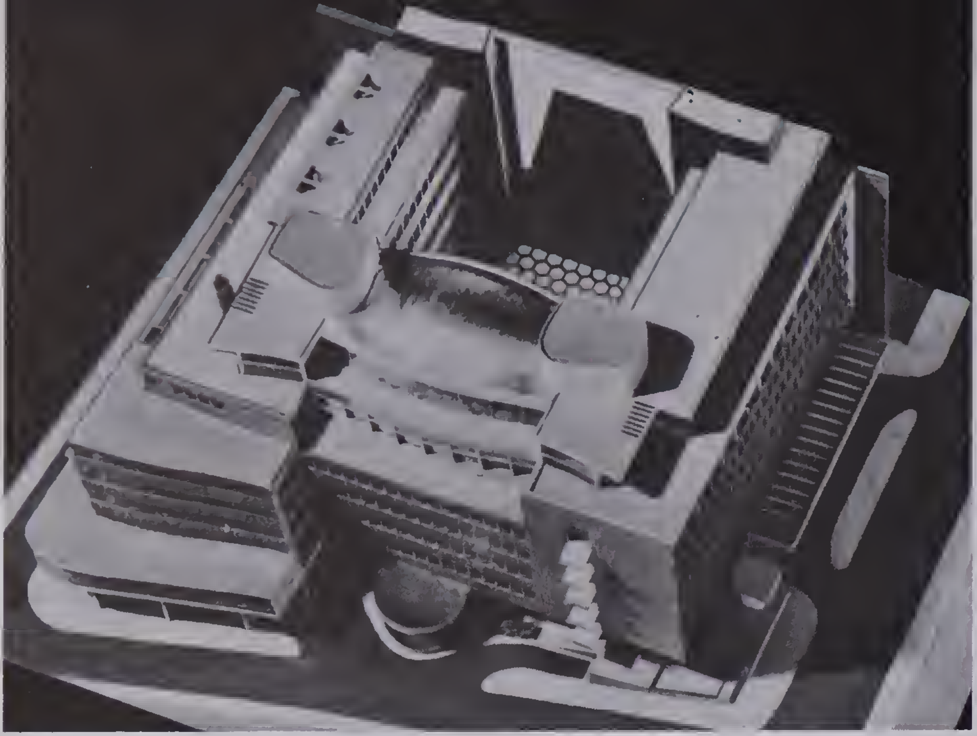


4

5

The drawings by Leonardo da Vinci, **1**, **2**, *and the sketches from an architect's notebook of 1235,* **3**, *show how close art and science were in the past. Leonardo was interested not only in the surface form of the human body but also in its mechanics. The medieval architect attempted to treat the drapery with the same precision as architecture. We have already seen that modern objects, too, may be the result of both scientific and artistic thought. The designer of the pick-up,* **5**, *considered not only its efficiency but also its appearance. Each detail is well designed in its own right and in its relation to the other parts. The resultant structure is therefore harmonious. How difficult we should find it to distinguish between the artistic and the scientific thought that went into the creation of this pick-up.*

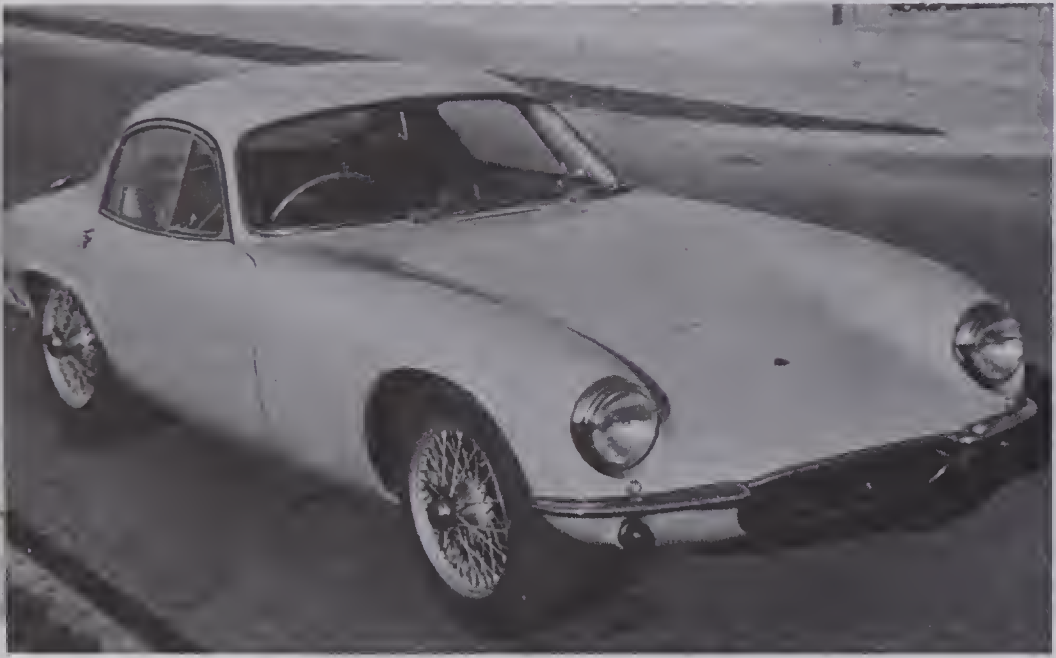
SHURE

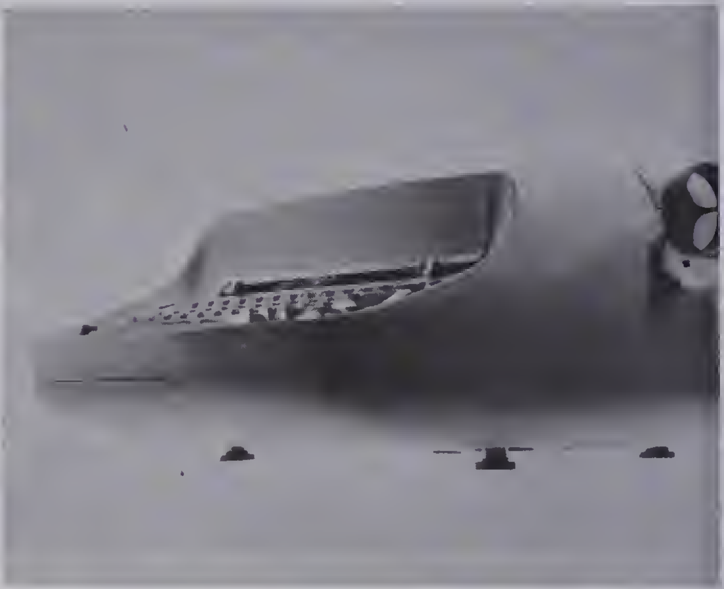


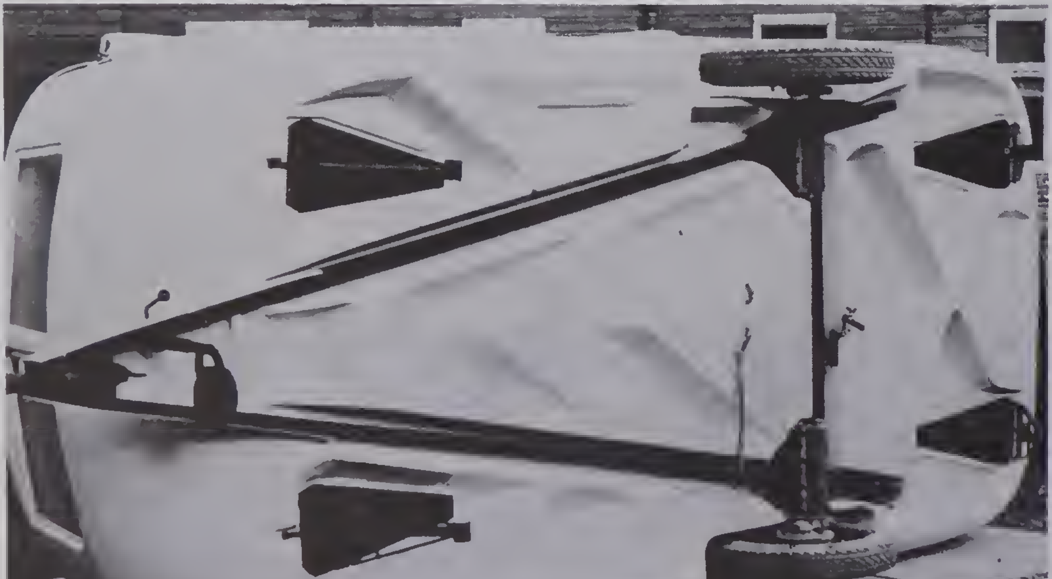
1. A model of the building whose interior you saw on page 95. The ceiling pattern of the hall can be clearly seen. Although complicated in itself it is part of the still more complicated scheme of the whole building.
2. The Lotus Elite sports car. It has a fibreglass body which is designed to offer the least resistance to air currents.
3. An electric typewriter
These three objects are examples of what can be achieved when art and science work together. Try to explain in what way each has contributed to the final shapes.
But not all modern shapes are as well conceived as these. The construction of the mechanical part of the caravan is well thought out and efficient, 4, *but the upper part is confused, with a lack of relationship between the component shapes,* 5. *What do you think has gone wrong?*

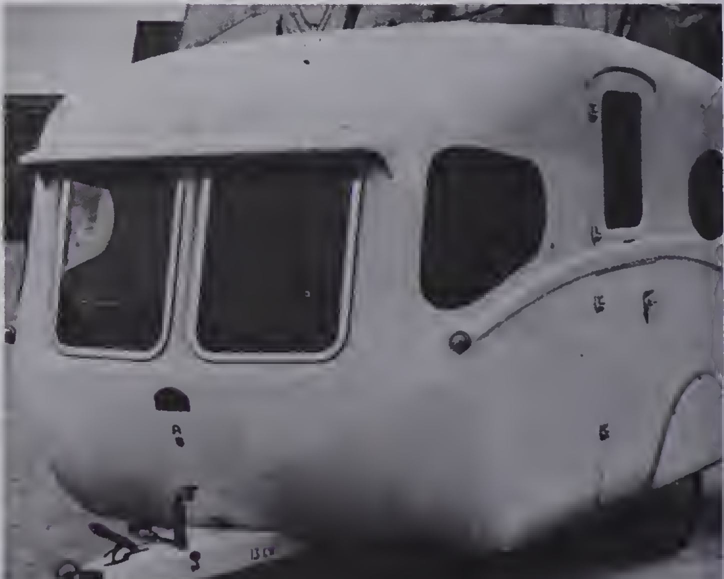
1

2 3









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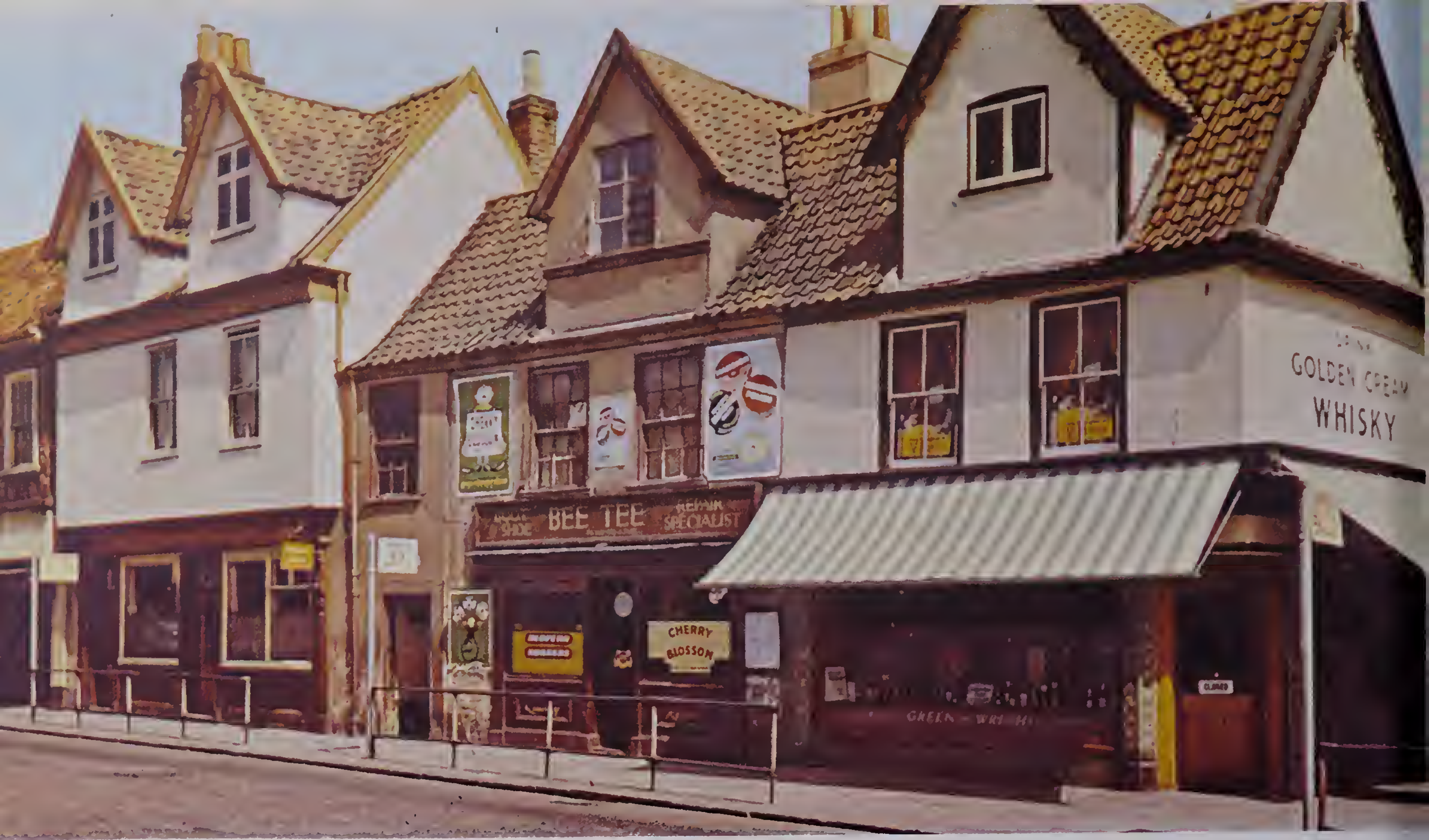
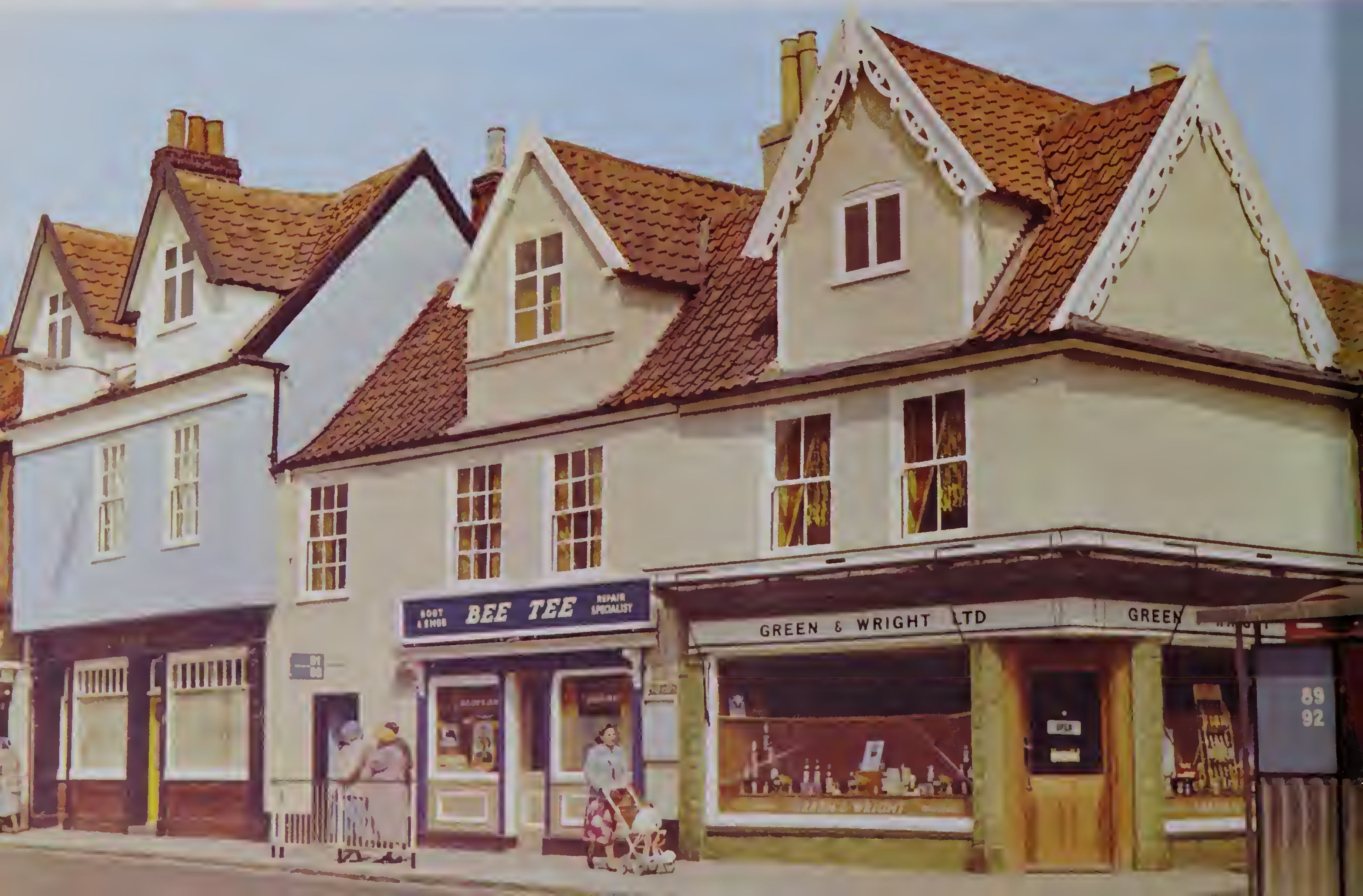

GOLDEN CREAM
WHISKY
BEE TEE
SHOE
REPAIR SPECIALIST
CHERRY BLOSSOM
GREEN & WRIGHT


BOOT & SHOE
BEE TEE
REPAIR SPECIALIST
GREEN & WRIGHT LTD
GREEN
89
92

We must try to arrange our surroundings in a series of harmonious relationships. In the living room, for instance, there are relationships between the structure, the materials and the surfaces of the room, and the shapes of the furniture. All this is enriched by the colour relationships which reflect those within the painting in the foreground. The shapes and surfaces of everyday objects, living rooms, places of work, and even whole streets can be tied together by colour relationships. The pictures on the left show the same street before and after painting. Which do you think is better and why?

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